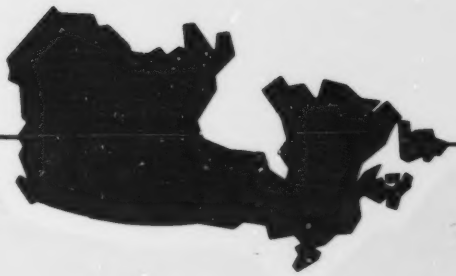
Agriculture Canada
Canadian Forestry Service

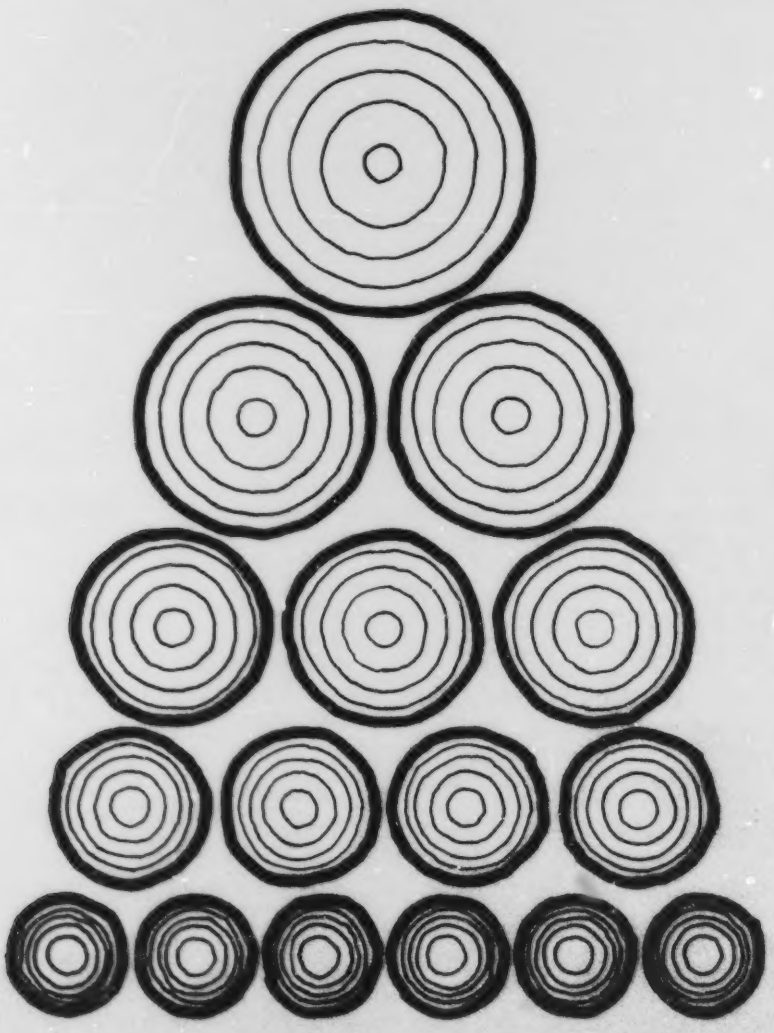
Agriculture Canada
Service canadien des forêts

An update (1970/71-1982) of the Annotated Bibliography on Initial Tree Spacing

F. Evert



Information Report PI-X-44
Petawawa National Forestry Institute



85-4791/

PETAWAWA NATIONAL FORESTRY INSTITUTE

The Petawawa National Forestry Institute (PNFI) was formed on April 1, 1979, as the result of an amalgamation of the Petawawa Forest Experiment Station with the Ottawa-based Forest Management and Forest Fire Research Institutes. The Forestry Statistics and Systems Branch was established at PNFI in 1980.

In common with the rest of the Canadian Forestry Service, the Petawawa National Forestry Institute has as its objective the promotion of better management and wiser use of Canada's forest resource to the economic and social benefit of all Canadians. Because it is a national institute, particular emphasis is placed on problems that transcend regional boundaries or that require special expertise and expensive equipment that cannot be duplicated in CFS regional establishments. Such research is often performed in close cooperation with staff of the regional centres or provincial forest services.

Research at the Institute is in two main areas:

FIRE RESEARCH AND REMOTE SENSING. Every year in Canada large areas of productive forest are destroyed by fire. Research concentrates on studies of forest fire behaviour, the development of new methods of fire control, the evaluation of fire-fighting equipment and retardants, and the development of computerized fire management systems that are rapidly finding applications with fire-fighting agencies across the country. The environmental and economic impact of forest fires and the use of fire as a silvicultural tool for intensive forest management are also studied.

In remote sensing, investigations are made into the application of modern satellite and airborne remote sensing systems to forestry problems. In this respect, the ARIES digital image analysis system is proving invaluable.

INTENSIVE FOREST MANAGEMENT. As Canada moves into more intensive management of its forest to meet expected increases in demand for this vital resource, the role of this program will become increasingly important. An extensive reforestation program will require a steady supply of high-quality seed of the desired species. Improved growing stock, obtained through tree breeding and forest genetics research, is highly desirable. Increased emphasis is being placed on using the entire above-ground portion of the tree (biomass), but the effect on the environment of this and other forms of intensive management has to be carefully monitored. Biotechnological methods of improving yield while maintaining site productivity are being investigated.

In support of its research programs, the Institute has at its disposal a 98 km^2 area of forest in the western part of the Petawawa military reserve. Records of experiments and sample plots have been maintained since the 1920s. The forest also serves as a field laboratory for students from local schools, and a visitor centre is operated during the summer months.

The operations of PNFI also include THE FORESTRY STATISTICS AND SYSTEMS BRANCH (FSSB) which is responsible for the acquisition and publication of national information on the forests of Canada. Through the Canadian Forest Inventory Committee, which is comprised of provincial and federal forestry officials, the FSSB works in close cooperation with provincial forest agencies to improve and standardize the information available on Canada's forest resources.

Through the FORSTATS program, which involves all regional establishments of the Canadian Forestry Service, the FSSB coordinates the acquisition and publication within the CFS of national statistics on the forest of Canada.

Every five years, the FSSB publishes Canada's Forest Inventory; the official report on the location, extent, species, and condition of the forest resource. In addition, the FSSB is working closely with the provinces to expand the information available on changes to the forest from fire, harvesting, insects and disease, and from forest management activities. This information is essential to the development of sound policies for the improved management of this important and renewable natural resource.

AN UPDATE (1970/71-1982) OF THE ANNOTATED BIBLIOGRAPHY ON INITIAL TREE SPACING

Information Report PI-X-44

F. Evert

Petawawa National Forestry Institute
Canadian Forestry Service
Agriculture Canada
1984

©Minister of Supply and Services Canada 1984
Catalogue No. Fo46-11/44-1984E
ISSN 0706-1854
ISBN 0-662-13621-7

Additional copies of this publication can be obtained from

Technical Information and Distribution Centre
Petawawa National Forestry Institute
Agriculture Canada
Chalk River, (Ont.)
K0J 1J0

Telephone 613 589-2880

Cette publication est aussi disponible en français sous le titre **Mise à jour (1970/71 à 1982) de la bibliographie annotée sur l'espacement initial des arbres.**

Contents

iv	Abstract/Résumé
1	Introduction
2	Language symbols
3	Abbreviations, units and symbols
6	Vernacular names
8	Plantation spacing metric conversion table
9	Species index
18	Subject index
29	Co-author index
33	Annotated bibliography - alphabetically by senior author

Abstract

This bibliography, presented alphabetically by author, contains 513 references from the world literature, and is a sequel to two previous publications on initial tree spacing covering the period 1920-1970/1971.

Résumé

Dans cette bibliographie, présentée sous forme alphabétique, l'auteur a inclus 513 ouvrages de référence choisis parmi la littérature du monde. C'est la suite aux deux publications précédentes qui ont traité de l'espacement initial des arbres pour la période 1920 à 1970/1971.

AN UPDATE (1970/71-1982) OF THE ANNOTATED BIBLIOGRAPHY ON INITIAL TREE SPACING

INTRODUCTION

This bibliography is a sequel to two previous publications, covering the period 1920 to 1970/1971.* The present volume, like the previous bibliographies, includes studies on research and operational practices that involve the spacing at which plantations were established, or the uniform spacing to which stands were thinned before the onset of intertree competition.

The bibliography, presented alphabetically by senior author, contains 513 references from the world literature covering the period 1970/1971 to 1982. Co-author, species, and subject indexes are included to facilitate the use of this book.

The volume was compiled using Forestry Abstracts as the main source of information. The language symbols, units, vernacular names, and abbreviations, except those in bibliographic citations, conform to that journal's usage. Abbreviations used in bibliographic citations conform to those listed in the Serial Sources for the Biosis Data Base, volume 1982, and the Word-Abbreviation List (1971 edition) of the American National Standards Institute.

All publication titles are given in English only (translated, if necessary).

---

*Evert, F. 1971. Spacing studies-a review. Can. For. Serv., Forest Management Inst., Inf. Rep. FMR-X-37. ix+95 p.

Evert, F. 1973. Annotated bibliography on initial tree spacing. Can. For. Serv., Forest Management Inst., Inf. Rep. FMR-X-50. vii+143 p.

F. Evert is a research scientist at the Petawawa National Forestry Institute.

Manuscript approved for publication: 16 November 1984.

Language symbols. Capital initial letters indicate the language of the text, small letters the language(s) of the summary. The following abbreviations are used:

Af	=	Afrikaans
Ar	=	Arabic
Az	=	Azerbaijan (i)/ Azerbaid-zhani/ Azerbaidzhanian
Be	=	White Russian
Bg	=	Bulgarian
Ch	=	Chinese
Cs	=	Czech
Da	=	Danish
De	=	German
Ee	=	Estonian
En	=	English
Es	=	Spanish
Fi	=	Finnish
Fr	=	French
Gr	=	Greek
He	=	Hebrew
Hindi	=	Hindustani
Hu	=	Hungarian
In	=	Indonesian
Is	=	Icelandic
It	=	Italian
Ja	=	Japanese
Ko	=	Korean
Li	=	Lithuanian
Lv	=	Latvian
Ma	=	Macedonian
My	=	Malay/ Bahasamalaysia
Nl	=	Dutch
No	=	Norwegian
Pl	=	Polish
Pt	=	Portuguese
Ro	=	Rumanian
Ru	=	Russian
Sh	=	Serbo-Croatian
Sk	=	Slovakian
Sn	=	Slovenian
Sv	=	Swedish
Ta	=	Tajik/Tadzhik
Tr	=	Turkish
Uk	=	Ukrainian

Abbreviations, units, and symbols. Standard SI symbols are used for metric units; these are not included in the present listing. Occasionally, other symbols not listed below are used when no difficulty is anticipated for the reader, including many geographical abbreviations such as ACT, UK, PA, etc.

A	Angstrom
AAS	atomic absorption spectrometry
ABA	abscisic acid
a.e.	acid equivalent
AFNOR	Association Français de Normalisation
AFOCEL	Association Forêt-Cellulose
a.i.	active ingredient
alt.	altitude
approx.	approximately
ARMEF	Association pour la Rationalisation et la Mécanisation de l'Exploitation Forestière
ASTM	American Society for Testing Materials
atm	(standard) atmosphere
Aug.	August
av.	average
b.a.	basal area
bar	bar
bd ft	board feet
b.h.	breast height
BHC	benzene hexachloride
BOD	biochemical oxygen demand
BP	before present
BS(I)	British Standard(s) (Institution)
Btu	British thermal unit
c.a.i.	current annual increment
cal	calorie
CCA	copper-chrome-arsenic
c.e.c.	cation exchange capacity
Ci	curie
COD	chemical oxygen demand
coeff.	coefficient
COMECON	Council for Mutual Economic Aid
conc.	concentrated
concn.	concentration(s)
const.	constant
CSF	Canadian standard freeness
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
cv.	cultivar
dbh	diameter at breast height
DDT	dichlorodiphenyltrichloroethane
diam.	diameter
DIN	Deutsches Institut fur Normung
dil.	dilute
DM	dry matter
DMSO	dimethyl sulphoxide
E.	east
ECE	Economic Commission for Europe
EC	European Communities
EM	electron microscope
e.m.c.	equilibrium moisture content
EPR	electron paramagnetic resonance
equiv.	equivalent
ESR	electron spin resonance
et al.	and others
F	filial generation
°F	degree Fahrenheit
FAO	Food and Agriculture Organization
Feb.	February
f.sp.	special form
ft	foot/feet
GA	gibberellic acid
gal	gallon (Imperial or US)
GC	gas chromatography
GOST	Gosudarstvennyi Obshchesoyuznyi Standart
h	hour
ha	hectare
hp	horse power
ht.	height
IAA	indole-acetic acid
IB	internal bond
IBA	indole-butyric acid
IBP	International Biological Programme
IR	infrared
ISO	International Organization for Standardization

IUFRO	International Union of Forestry Research Organizations
Jan.	January
kgf	kilogramme-force
lat.	latitude
lb	pound (weight)
lbf	pound-force
LC	lethal concentration
LD	lethal dose
long.	longitude
LVL	laminated veneer lumber
M	molar
m.a.i.	mean annual increment
max.	maximum
mbar	millibar
mc.c	moisture content
MDF	medium density fibre board
min	minute (time)
min.	minimum
ml	millilitre
MMA	methyl methacrylate
MOE	modulus of elasticity
mol	mole
mol.	molecular
MOR	modulus of rupture
N.	north
NAA	naphthylacetic acid
NE	north-east
NMR	nuclear magnetic resonance
Nov.	November
n.s.d.	no significant difference; not significantly different
NSSC	neutral sulphite semi-chemical
NW	northwest
o.b.	over bark
Oct.	October
OECD	Organization for Economic Cooperation and Development
opt.	optimum
OSB	oriented structural board
oz	ounce
P	probability
p.a.	per annum
p.a.i.	periodic annual increment
PCP	pentachlorophenol
PEG	polyethylene glycol
PF	phenol formaldehyde
p.p.	partly, in part
p.p.m.	parts per million
p.p.t.	parts per thousand
PVA	polyvinyl acetate
PVC	polyvinyl chloride
R	röntgen
r	coefficient of correlation
rad	rad
RF	resorcinol formaldehyde
RH	relative humidity
r.p.m.	revolutions per minute
S.	south
s.d.	standard deviation
SE	south-east
SEM	scanning electron microscope
Sept.	September
sig.	significant(ly)
s.l.	in a broad sense
sol.	solution(s)
sp.	species
sp.nov.	new species
s.s.	in a narrow sense
ssp.	subspecies
SW	south-west
syn.	synonym
t	tonne
TCA	trichloroacetic acid
TEM	transmission electron microscope
temp.	temperature(s)
t.&g.	tongued and grooved
TLC	thin-layer chromatography
u.b.	under bark
UF	urea formaldehyde
UHF	ultra high frequency
ULV	ultra low volume
UNDP	United National Development Programme
USDA	United States Department of Agriculture
UV	ultraviolet
var.	variety
VHF	very high frequency
viz.	namely
vol.	volume
vs.	versus
W.	west
wk	week
w.p.	wettable powder
wt.	weight
yr	year

3P	probability proportional to prediction	⊥	perpendicular
--'	minute (angle)	†	appears on some abstracts taken from Soils and Fertilizers
--"	second (angle)		
	parallel		

Vernacular names. The vernacular names listed below may be used in the abstracts instead of Latin names. Indexing is by Latin nomenclature.

acacia	Acacia (see also black wattle)
alder	Alnus
ash	Fraxinus (generally F. excelsior unless otherwise indicated)
Austrian pine	Pinus nigra (also Corsican pine)
balsa	Ochroma lagopus
balsam fir	Abies balsamea
bamboo	Bambuseae
basswood	(see linden)
beech	Fagus (generally F. sylvatica unless otherwise indicated)
birch	Betula (B. alba is used for undifferentiated B. pendula and B. pubescens)
black spruce	Picea mariana
black walnut	Juglans nigra
black wattle	Acacia mearnsii
broadleaf	Angiospermae (tree; see also hardwood)
cashew	Anacardium occidentale
chir	Pinus roxburghii
coconut	Cocos nucifera
conifer	Coniferae (see also softwood)
Corsican pine	Pinus nigra (also Austrian pine)
deodar	Cedrus deodara
dipterocarp	Dipterocarpaceae
douglas-fir	Pseudotsuga menziesii
eastern hemlock	Tsuga canadensis
eastern white pine	Pinus strobus (also Weymouth pine)
elm	Ulmus
Engelmann spruce	Picea engelmannii
eucalypt	Eucalyptus
fig	Ficus
fir	Abies (see also douglas fir)
hardwood	Angiospermae (timber; see also broadleaf)
hazel	Corylus avellana
hem-fir	Tsuga + Abies (lumber)
hemlock	(see eastern, western hemlock)
hickory	Carya
hinoki	Chamaecyparis obtusa
holly	Ilex
hoop pine	Araucaria cunninghamii
hornbeam	Carpinus betulus
jack pine	Pinus banksiana
juniper	Juniperus
kauri	Agathis (A. australis in New Zealand)
larch	Larix (see also tamarack)
linden	Tilia (also referred to elsewhere as 'lime' and 'basswood')
loblolly pine	Pinus taeda (see also southern pine)
lodgepole pine	Pinus contorta
longleaf pine	Pinus palustris (see also southern pine)
mango	Mangifera indica
maple	Acer
maritime pine	Pinus pinaster
mulberry	Morus
neem	Azadirachta indica
Norway spruce	Picea Abies
oak	Quercus (Q. robur s.l. is used for undifferentiated Q. robur and Q. petraea)
palm	Palmae
Parana pine	Araucaria angustifolia
pine	Pinus (see also hoop pine, Parana pine)
ponderosa pine	Pinus ponderosa
poplar	Populus (see also yellow poplar)
radiata pine	Pinus radiata (also referred to elsewhere as 'Monterey pine')
rattan	Calamus and/or Daemonorops (mainly)
red oak	Quercus rubra (northern red oak of the USA)

robinia	*Robinia pseudoacacia* (also referred to elsewhere as 'false acacia', 'locust' etc.)
rubber	*Hevea brasiliensis* (unless otherwise indicated)
sal	*Shorea robusta*
sandalwood	*Santalum album*
Scots pine	*Pinus sylvestris*
shortleaf pine	*Pinus echinata* (see also southern pine)
silver fir	*Abies alba*
Sitka spruce	*Picea sitchensis*
slash pine	*Pinus elliottii* (see also southern pine)
softwood	Gymnospermae (timber; see also conifer)
southern pine	*Pinus echinata*, *P. elliottii*, *P. palustris* and *P. taeda* (indexed as *P.* 'Southern')
spruce	*Picea*
sugar maple	*Acer saccharum*
sugi	*Cryptomeria japonica*
sweetgum	*Liquidambar styraciflua*
tamarack	*Larix laricina*
teak	*Tectona grandis*
walnut	*Juglans regia* (see also black walnut)
Weymouth pine	*Pinus strobus* (also eastern white pine)
white oak	*Quercus alba*
white spruce	*Picea glauca*
western hemlock	*Tsuga heterophylla*
willow	*Salix*
yellow poplar	*Liriodendron tulipifera* (also referred to elsewhere as 'tulip tree')
yew	*Taxus baccata* (other species by Latin names)

PLANTATION SPACING METRIC CONVERSION TABLE*

feet	m nominal ft	metres
3.3 x 3.3	1 x 1	0.3 x 0.3
6.6 x 6.6	2 x 2	0.6 x 0.6
9.8 x 9.8	3 x 3	0.9 x 0.9
13.1 x 13.1	4 x 4	1.2 x 1.2
16.4 x 16.4	5 x 5	1.5 x 1.5
19.7 x 19.7	6 x 6	1.8 x 1.8
23.0 x 23.0	7 x 7	2.1 x 2.1
26.2 x 26.2	8 x 8	2.4 x 2.4
29.5 x 29.5	9 x 9	2.7 x 2.7
32.8 x 32.8	10 x 10	3.0 x 3.0
36.1 x 36.1	11 x 11	3.4 x 3.4
39.4 x 39.4	12 x 12	3.7 x 3.7
42.6 x 42.6	13 x 13	4.0 x 4.0
45.9 x 45.9	14 x 14	4.3 x 4.3
49.2 x 49.2	15 x 15	4.6 x 4.6

How to use this table:

From nominal column

a) If value is in feet, read equivalent in metres from right-hand column, e.g. if nominal value is 5 x 5 ft, then equivalent is 1.5 x 1.5 m.

b) If value is in metres, read equivalent in feet from left-hand column, e.g. if nominal value is 2 x 2 m, then equivalent is 6.6 x 6.6 ft.

The table is based on conversions

a) 1 ft = 0.3048 m
b) 1 m = 3.2808 ft

*Compiled by W.M. Stiell (1973) Petawawa National Forestry Institute, Canadian Forestry Service, Chalk River, Ontario.

SPECIES INDEX

The senior author is listed, followed by year of publication

Abies spp.
Meyer R. 75

A. alba
Kramer W. 80

A. balsamea
Day R.L. et al. 70
Nostrand R.S. Van 75
Piene H. 78

A. grandis
Dohrenbusch A. 81
Oswald H. 80

A. sachalinensis
Sakamoto T. 69
Sato S. 72

Acacia spp.

A. decurrens
Fonseca J.M.M.A. et al. 74

A. farnesiana
Hasan S.M. et al. 80

A. mearnsii
Husain A.N.M. et al. 80

A. mollissima
Goo M. 71

Acer spp.

A. compestre
Aliev Sh. 75
Dimitrov Kh. 79

A. negundo
Geyer W.A. 81

A. saccharinum
Geyer W.A. 78,81

A. saccharum
Lancaster K.F. et al. 74

A. tataricum
Dimitrov Kh. 79

Albizia falcataria
Palit S. 80

Alnus spp.

A. glutinosa
Clark P.M. et al. 79
Geyer W.A. 81
Kloosterhuis W.E.H. 76
Wittwer R.F. et al. 78

A. hirsuta var. sibirica
Wada K. et al. 72

A. incana
Pohjonen V. 74

Amyris barbata
Santander Flores C. et al. 74

Anthocephalus cadamba
Maun M.M. et al. 72

A. chinensis
Shim P.S. 73

Araucaria spp.

A. angustifolia
Fishwick R.W. 76
Gurgel Filho O.A. 75

Aspidosperma polyneuron
Gurgel Filho O.A. 75

Balfourodendron riedelianum
Gurgel Filho O.A. 75

Betula spp.

B. alleghaniensis
Hoyle M.C. 75

B. nigra
Wittwer R.F. et al. 78

B. papyrifera
Hoyle M.C. 75

B. pendula
Kloosterhuis W.E.H. 76
Parviainen J. 79

B. platyphylla
Sakamoto T. 69

B. verrucosa
Erken T. 72
Torokhtun I.M. 81

B. verrucosa carelica
Litvak P.V. et al. 77
Sakss K. et al. 69

Caesalpinea leiostachya
Gurgel Filho O.A. 75

Calocedrus (Libocedrus) formosana
Pan C.S. 74

Calophyllum brasiliense
Schmidt P.B. et al. 72

Carapa guianensis
Schmidt P.B. et al. 72
Volpato E. et al. 73

Carya spp.
Osterhaus C.A. et al. 78

Cedrela odorata
Quaynor S.O-A. 71

Cedrelinga cateniiformis
Volpato E. et al. 73

Centrolobium spp.

C. robustum
Fonseca J.M.M.A. et al. 74

C. tomentosum
Gurgel Filho O.A. 75

Chamaecyparis obtusa
Nogami K. 74

Cinnamomum camphora
Mugasha A.G. 78

Coumarouna odorata
Schmidt P.B. et al. 72

Cryptomeria japonica
Wang T.T. 77
Yang Y.C. 72
Yang Y.C. et al. 76

Cunninghamia lanceolata
Fonseca J.M.M.A. et al. 74
Pan C.S. 74

Cupressus lusitanica
Alder D. 79
Karani P.K. 76
Veldhoen B.J. 70

Diplotropis spp.
Schmidt P.B. et al. 72

Elaeagnus umbellata
Clark P.M. et al. 79

Esenbeckia leiocarpa
Gurgel Filho O.A. 75

Eucalyptus spp.
Poynton R.J. 81

E. alba
Brasil M.A.M. et al. 71
Coelho A.S.R. et al. 70
Coelho A.S.R. et al. 71
Freitas E.R de et al. 72
Mello H.A. et al. 71,72,

E. astringens
Den Salem B. 75

E. camaldulensis
Bozzo D. 74
Delwaulle J.C. 79

E. citriodora
Gurgel Filho O.A. 73
Gurgel Filho O.A. et al. 73

E. diversicolor
Schuster C. 78

E. dunnii
Lisbao Junior L. 80

E. globulus
Cozzo D. 74
Ferrari G. et al. 79

E. grandis
Brasil M.A.M. et al. 71
Coelho A.S.R. et al. 70,71
Donald D.G.M. et al. 77
Dyson W.G. 74
Freitas E.R. de et al. 72
Laar A. Van et al. 79
Mello H.A. et al. 71,72,76
Meskimen G. et al. 78
Pande G.C. 74
Schonau A.P.G. 74

E. (Mysore) hybrid
Sharma R.P. 79

E. propinqua
Coelho A.S.R. et al. 70
Coelho A.S.R. et al. 71
Freitas E.R. de 72
Mello H.A. et al. 71,72,76

E. robusta
Pan C.S. 74

E. saligna
Brasil M.A.M. et al. 71
Coelho A.S.R. et al. 70,71
Couto H.T.Z. et al. 73
Freitas E.R. de et al. 72
Mello H.A. et al. 70,71,
72,76
Walters G.A. 73,80
Whitesell C.D. 75

E. saligna X E. grandis
Dyson W.G. 74

E. tereticornis
Bhatia K.S. 80
Sharma R.P. 78

E. X trabutii
Ferrari G. et al. 79

E. urophylla
Brandi R.M. et al. 77
Mello H.A. et al. 76

E. viminalis
Cozzo D. 74

Fagus spp.
Burschel P. et al. 74
Jeschke S. 77
Solymos R. 70

F. sylvatica
Muhle O. et al. 79
Tyshkevich G.L. 76

Fraxinus spp.

F. oxycarpa
Dimitrov Kh. et al. 79

F. pennsylvanica
Dimitrov Kh. et al. 79
George E.J. et al. 73
Wittwer R.F. et al. 78

Gleitsia triacanthos
Dimitrov Kh. et al. 79

Gmelina arborea
Maun M.M. 77
Mendoza V.B. et al. 76
Sazon A.C. 72

Goupia glabra
Volpato E. et al. 73

Hippophaë rhamnoides
Vashchenko I.M. 79

Hymenaea stilbocarpa
Gurgel Filho O.A. 75

Juglans spp.

J. nigra
Clark P.M. et al. 79
Dearborn M. 76
Garavel L. 72
Parrot L. 71

J. regia
Garavel L. 72

Juniperus virginiana
Haverbeke D.F. Van 77

Larix spp.
Brammanis L. 75
Meyer R. 75
Zavitkowski J. et al. 78

L. decidua
Bergel D. 73
Cook D.B. 74
Delvaux J. 75
Fromsdorf U. et al. 80
Gramada S. 72
Hamilton G.J. et al. 74
Morrow R.R. 78
Mulder D. 79

L. laricina
Strong T.F. et al. 78

L. leptolepis
Berben J.C. 78
Bergel D. 73
Cook D.B. 74
Dik E.J. 75
Divoux A. et al. 80
Hamilton G.J. et al. 74
Jacquemin A. 73
Massinet S. Du 75
Sakamoto T. 69
Westra J.J. 75

L. occidentalis
Schmidt W.C. 78

L. sibirica
Khizhnyak N.I. 74
Nekhaichuk O.G. et al. 79, 82
Romanov A.P. 75
Utkin A.I. et al. 80

L. sukaczewii
Parviainen J. 79

Laurus nobilis
Pirtskhalaishvili S. Kh. et al. 75

Leucaena leucocephala
Palit S. 80

Liquidambar styraciflua
Gibson G.E. et al. 77

Liriodendron tulipifera
Francis J.K. 77

Melia azedarach
Fonseca J.N.M.A. et al. 74

Nothofagus procera
Cruwys G.E. 72

Ocotea usambarensis
Mugasha A.G. 78

Octomeles sumatrana
Shim P.S. 73

Ostrya spp.
Solymos R. 70

Paratecoma peroba
Anon. 71

Peltophorum vogelianum
Gurgel Filho O.A. 75

Phyllostachys edulis
Kim S.I. et al. 76

Phyllostachys nigra
Kim S.I. et al. 76

Picea spp.
Abetz P. 73
Burschel P. et al. 74
Delvaux J. 81
Gouttin P. 74
Johann K. 74
Kramer H. 75
Kramer H. et al. 77
Meyer R. 75
Moller C.M. 73
Pisarenko A.I. et al. 78
Pollanschutz J. 74
Vyskot M. 78

P. abies
Abetz P. 76
André P. 76,78
Assmann E. 75
Barannik A.B. 78
Been A. 72
Braastad H. 79
Burschel P. 81
Delvaux J. 70,75
Dittmar O. et al. 74
Divoux A. et al. 80
Dotsenko A.P. 81
Eriksson L. 77
Erken T. 72
Gathy P. 75
Griess O. 79
Hallik J. 77
Hamilton G.J. et al. 74
Hannelius S. 78
Haveraaen O. 81
Ivanov S.M. 74
Jakobsen B. 79
Johann K. et al. 80
Kairyukshtis L.A et al. 75
Kramer H. 80,80,80
Kramer H. et al. 78
Larin V.B. et al. 72
Martynov A.N. 77
Merzlenko M.D. 74
Mracek Z. 70,80
Muhle O. et al. 72
Nekhaichuk O.G. et al. 79
Parviainen J. 79
Persson A. 75
Pisarenko A.I. et al. 79
Piskun B. 72,72
Pollanschutz J. 74
Prokop'ev M.N. 76
Razin G.S. 79
Recklinghausen H. Von 81
Romanov A.P. 75
Sakamoto T. 69
Sato S. 72,73
Smirnov N.A. 75

Solymos R. 70
Tarasenko V.P. et al. 71
Thomasius H. 72,74
Tomazius Kh. O. 78
Ul'yanov V.I. 81,81
Zhuraleva M. et al. 81
Zimmermann H. 82

P. glauca
Bella I.E. et al. 74,80
Berry A.B. 74
Stiell W.M. 69

P. mariana
Nostrand R.S. Van 75

P. orientalis
Saradzhishvilli D.G. 76

P. sitchensis
Edwards P.N. et al. 79
Gallagher G.J. et al. 80
Gardiner J.J. et al. 78
Gilliland J. 80
Hamilton G.J. et al. 74
Kilpatrick D.J. et al. 81
Lynch T.J. 80
Nostrand R.S. Van 75
O'Brien D. 80
Ward D. et al. 76

Pinus spp.
Brabander H.D. et al. 76
Molino O. 78
Vlaheli I. et al. 74

P. banksiana
Bella I.E. 74
Bella I.E. et al. 74,80
Strong T.F. et al. 78
Zavitkovski J. et al. 77,81

P. brutia
Hasan S.M. et al. 80
Osterhaus C.A. et al. 78

P. caribaea
Martin B. 70

P. caribaea var bahamensis
Acosta Romero R. 76
Simoes J.W. et al. 70

P. caribaea var. caribaea
Acosta Romero R. 76
Hochmut R. et al. 74
Molino O. 72

P. caribaea var. hondurensis
de Vries P.G. et al. 78
Gurgel Filho O.A. et al. 70
Haron B. Hj. Abu Hassan 76
Molino O. 72
Pedroso L.M. et al. 71
Simoes J.W. et al. 74
Whitmore J.L. et al. 80

P. clausa
Burns R.M. et al. 78

P. clausa immuginata
Rockwood D.L. et al. 80

P. contorta
Gallagher G.J. et al. 80
Lynch T.J. 80
O'Brien D. 80
O'Flanagan L.P. 80

P. contorta var. latifolia
Gomis H.D. 73

P. cubensis
Acosta Romero R. 76
Hochmut R. et al. 74

P. echinata
Arnold L.E. 78
Gilmore A.R. 78
Gilmore A.R. et al. 74
Osterhaus C.A. et al. 78
Phipps H.M. 73
Williston H.L. 78

P. elliottii
Anon. 71a,72b
Bennett F.A. 71
Berenhauser H. 71
Fishwick R.W. 76
Ladrach W.E. 74
Lewis C.E. et al. 72
Mann W.F.J. et al. 77
May J.T. et al. 73
Montagna R.G. et al. 73
Sarigumba T.I. et al. 79
Schultz R.P. 72

P. elliottii var. elliottii
Enghardt H.G. et al. 72
Gurgel Filho O.A. et al. 70,73
Mann W.F. Jr. 71,72
Molino O. 72

P. insularis
Penafiel S.R. 73

P. kesiya
Barangan F. 78
Endean F. et al. 72

P. khasaya (P. kesiya)
Acosta Romero R. 76

P. koraiensis
Yurov I.V. 75

P. massoniana
Kihlstock N. et al. 79

P. mugo mughus
Kloosterhuis W.E.H. 76

P. nigra
B'Chvarov D. 80
B'Chvarov D. et al. 72
Gathy P. 75
Gramada S. et al. 72
Lyapova I. 80
Nikolov S. et al. 79
Solymos R. 75
Zhelev I. 76

P. nigra var. calabrica
Anon. 72a

P. nigra var. caramanica
Aliev Sh. 75

P. nigra var. maritima
André P. et al. 75
Berben J.C. 75,75,78
Gathy P. 75

P. occidentalis
Acosta Romero R. 76

P. patula
Adlard P.G. et al. 74
Alder D. 79
Anon. 71a
Borota J. 71
Bredenkamp B. 80
Burgers T.F. 71
Chamshama S.A.O. et al. 80
Evans J. 76
Laar A. Van 78
Ladrach W.E. 74
Molino O. 72

P. pinaster
Eccher A. 74
Hopkins E.R. 71
Lemoine B. 80
Osterhaus C.A. et al. 78

P. ponderosa
Barrett J.W. 70,72
Haverbeke D.F. Van 77
Oliver W.W. 79

P. radiata
Alder D. 79
Borough C.J. 78
Chavasse C.G.R. et al. 81
Eccher A. 73,75
Garia S.J. et al. 78
Incoll W.D. et al. 79
Madgwick H.A.I. 81
McKinnell F.H. 71
Prado Donosso J.A. et al. 79,79
Rocuant Trucios L. 78
Siemon G.R. et al. 76
Sutton W.R.J. 71

P. resinosa
Barse R.G. et al. 80
Bella I.E. et al. 74,80
Laidly P.R. et al. 79
Lundgren A.L. 81
Morrow R.R. 74
Neary D.G. et al. 74
Stiell W.M. et al. 77

P. rigida
Kim D.C. et al. 74

P. roxburghii
Singh R.V. 77

P. strobus
Kantemirov Z. Kh. 75
Orlic S. 73
Sakamoto T. 69
Solymos R. 70

P. sylvestris
Babenko D.K. et al. 75
Belyi G.D. 75
Belyi G.D. et al. 80
Berben J.C. 75
Bergmann J.H. et al. 77
Bondarenko N. Ya. et al. 72
Botenkov V.P. 79
Brammanis L. 75
Chroust L. 73
Dittmar O. 75,77
Divoux A. et al. 80
Dozsa J. 74
Elfving B. 75
Eriksson L. 77
Erteld W. 75
Flohr W. 75
Gathy P. 75
Grigor'ev V.P. et al. 78
Hamilton G.J. et al. 74
Hattemer H.H. et al. 77
Haverbeke D.F. Van 77
Ipatov L.F. 80
Kern K.G. 73
Kloosterhuis W.E.H. 76
Koch H. 77
Korobov I.A. 78
Kramer H. 75,80
Krasnyatov V.V. 81
Kuz'michev V.V. et al. 79
Leikola M. et al. 77
Lepekhin A.V. 81
Meyer R. 75
Mitirev A.E. et al. 76
Mrazek F. 79
Nekhaichuk O.G. et al. 79
Onis'kiv N.I. 72
Orlic S. 71,73
Ovcharov G. 75
Parviainen J. 79
Persson A. 75,75,76,77
Pinchuk A.M. et al. 73
Pisarenko A.I. et al. 79
Popov V.K. 80
Popov V.K. et al. 81
Prokop'ev M.N. 76
Pulinets M.P. 81
Ryabokon A.P. 79
Sakamoto T. 69
Savina A.V. et al. 78
Shinkarenko I.B. et al. 76
Shinkaruk A.I. 75
Solymos R. 75
Stepanov L.I. 75
Tekhneryadnov A.V. et al. 73
Thomasius H. 72
Timofeev V.P. 74
Tolle H. 76
Utkin A.I. et al. 80
Vakulyuk P.G. et al. 80
Vakurov A.D. 79
Zajaczkowski J. 73
Zhelev I. 76
Zhuravleva M.V. et al. 81

P. taeda
Allen H.L. et al. 81
Anon. 71a
Arnold L.E. 78
Balmer W.E. et al. 75
Berenhauser H. 71
Choong E.T. et al. 74
Feduccia D.P. et al. 76
Gilmore A.R. 78
Gilmore A.R. et al. 74
Harms W.R. et al. 81
Ladrach W.E. 74
Lear D.H. Van et al. 73
Lohrey R.E. 72
Mann W.F. Jr. et al. 71, 77
McClurkin D.C. 76
Osterhaus C.A. et al. 78
Wearstler K.A. Jr. 79
Whitesell C.D. 74
Williston H.L. 79

P. tropicalis
Acosta Romero R. 76

P. virginiana
Österhaus C.A. et al. 78

Piptadenia spp.
Fonseca J.M.M.A. et al. 74

Platanus acerifolia
Netrebenko V.G. et al. 76

P. occidentalis
Belanger R.P. et al. 78
Dutrow G.F. 71
Geyer W.A. 81
Kennedy H.E. Jr. 75
Saucier J.R. et al. 72
Schlaegel B.E. 81
Steinbeck K. 72
Wittwer R.F. et al. 78,78
Wood B.W. et al. 76,77

P. orientalis
Bozhko V.E. 74

Platycyamus regnellii
Gurgel Filho O.A. 75

Populus spp. & hybrids
Halupa L. 72
Il'inskii V.D. et al. 75
Kolster H.W. 74-75
Nelson N.D. et al. 81
Orlova N.A. 73
Proni G. et al. 79
Sheedy G. 78
Stern R.C. 72
Stoiculescu C.D. 74

P. 'Androscoggin'
Bosch R. 81
Kolster H.W. et al. 74-75

P. 'Bachelieri'
Zakhariev B. et al. 80

P. balsamifera
Torokhtun I.M. 81

P. 'Barn'
Kolster H.W. 78
Kolster H.W. et al. 74-75, 79

P. 'Bietigheim'
Bosch R. 81

P. X 'canadensis'
Crowther R.E. 77

P. 'canadensis B-50'
Ganchev A. et al. 71

P. deltoides
Geyer W.A. 81
Krinard R.M. 71
Krinard R.M. et al. 75,80
Naidenova-Yaneva Ts. 73
Palashev I. et al. 73

P. deltoides 'Angulata' X P. trichocarpa
Menetrier J. 78

P. deltoides var. missouriensis X P. "italica"
Panetsos C.P. 80

P. deltoides var. missouriensis X P. nigra
Panetsos C.P. 80

P. deltoides var. missouriensis X P. nigra var. pubescens
Panetsos C.P. 80

P. 'Donk'
Kolster H.W. et al. 74-75, 79

P. 'Dorskamp'
Faber P.J. 77
Kolster H.W. 78
Kolster H.W. et al. 74-75, 79

P. euramericana (P. X canadensis aggr.) cv. 'I-214'
Hyun S.K. et al. 74
Sertmehmetoglu Z. et al. 72
Sheikh M.I. 78

P. euramericana (P. X canadensis aggr.)
Menetrier J. 78
Schipper A.L. Jr. 76

P. euramericana cv. 'I-476'
Hyun S.K. et al. 74

P. 'Fritzi Pauley'
Bosch R. 81
Kolster H.W. et al. 74-75,79

P. 'Gelrica'
Kohan S. 73

P. 'Grandis'
Kohan S. 73

P. 'I-214'
Carretero R.V. 72
Decei I. et al. 80
Dekanic I. 73
Fakirov V. 72a,72b,76c,76d
Frison G. 74,76,79,80
Ganchev A. et al. 71
Giordano E. et al. 79
Halupa L. et al. 75
Kohan S. 73
Kuzmanovic U. 73
Markovic J. 73,74-75
Prevosto M. et al. 80
Proni G. et al. 74,79
Sheikh M.I. 80
Zakhariev B. et al. 75, 80

P. I-262
Zakhariev B. et al. 80

P. I-455
Zakhariev B. et al. 80

P. 'Lons'
Bosch R. 81

P. 'Marilandica'
Decei I. et al. 80
Dekanic I. 73
Kohan S. 73

P. maximowiczii
Sakamoto T. 69

P. 'Muhle larsen'
Bosch R. 81

P. 'NE-49'
Bowersox T.W. et al. 76
Murphey W.K. et al. 77

P. 'NE-252'
Bowersox T.W. et al. 76
Murphey W.K. et al. 77

P. 'NE-388'
Bowersox T.W. et al. 76
Murphey W.K. et al. 77

P. 'Neupotz'
Bosch R. 81

P. nigra
Bosch R. 81

P. 'Northwest'
Crist J.B. et al. 75

P. Oxford
Bosch R. 81
Faber P.J. 78
Kolster H.W. 78

P. 'Rap'
Kolster H.W. et al. 74-75,79

P. 'Regenerata'
Decei I. et al. 80
Dekanic I. 73
Fakirov V. 76,76,80
Iliev A. 75

P. X 'Regenerata Deutschland'
Bosch R. 81

P. 'Robusta'
Dekanic I. 73
Faber P.J. 78
Kohan S. 73
Kolster H.W. 78
Stredicke R. 77

P. 'Robusta R-16'
Decei I. et al. 80
Stoiculescu C.D. 73,73

P. 'Rochester'
Bonduelle P. 77
Bosch R. 81
Kolster H.W. 78

P. 'Serotina'
Decei I. et al. 80
Dekanic I. 73
Iliev A. 75
Kohan S. 73
Szodfridt I. 72

P. tremula
Chistyakov A.R. et al. 79

P. tremula X P. tremuloides
Pohjonen V. 74

P. trichocarpa
Bosch R. 81
Decourt N. et al. 74
Heilman P.E. et al. 72,79, 81

P. trichocarpa 'Koreana 39'
Bonduelle P. 77

P. trichocarpa X P. koreana
Bosch R. 81

P. 'Tristis No. 1'
Crist J.B. et al. 75
Dawson D.H. et al. 76
Ek A.R. et al. 76,76
Zavitkovski J. 76,81

P. 'Vernirubens'
Denev D.A. 74
Fakirov V. 76,76
Ganchev A. et al. 71
Zakhariev B. et al. 80

P. Weltheimeipappel
Zakhariev B. et al. 80

Prosopis tamarugo
Elgueta Salinas H. et al. 71

Prunus spp.

P. avium
Beck O.A. 81

P. mahaleb
Dimitrov Kh. 79

Pseudotsuga spp.

P. menziesii
Abetz P. 71
Aussenac G. 79
Bartoli M. 71
Burschel P. et al. 74
Campbell R.K. et al. 73
Curtis R.O. et al. 74
Dagenbach H. 78
Delvaux J. 71,73
Divoux A. et al. 80
Dunsworth B.G. et al. 80
Gramada S. et al. 72
Hamilton G.J. et al. 74
Hapla F. 81
Hoyer G.E. et al. 76
Kenk G. et al. 80
Meyer R. 75
Mitchell K.J. 78
Oswald H. et al. 76
Reukema D.L. 79
Smith J.H.G. 78,80

P. menziesii var. viridis
Gomis H. 74

Quercus spp.
Aliev Sh. 75
Atamanyuk Yu. A. 71

Q. cerris
Dimitrov Kh. et al. 79

Q. frainetto
Bondarenko V.D. 76

Q. marilandica
Österhaus C.A. et al. 78

Q. palustris
Sancho R. 72

Q. petraea
Parde J. 78

Q. robur
André P. et al. 72
Dimitrov Kh. et al. 79
Gizatullin S. Kh. 73
Kloosterhuis W.E.H. 76
Onis'kiv N.I. 72
Oosterbaan A. 81
Savina A.V. et al. 78
Tolkachev L.N. 76

Q. rubra
Boudru M. 76
Dimitrov Kh. et al. 79
Kostov K.D. 75
Onis'kiv N.I. 72

Q. stellata
Österhaus C.A. et al. 78

Q. suber
Angel Menéndez M. 71

Robinia pseudoacacia
Clark P.M. et al. 79
Dimitrov Kh. et al. 79
Konnert V. 74
Torokhtun I.M. 81

Salix spp.
Il'inskii V.D. et al. 75
Sheikh M.I. 73

S. alba
Tihanyi Z. et al. 72

S. alba Bg 2/64
Tsanov Ts. I. 78

S. alba Donja Siga 1/23
Tsanov Ts. I. 78

S. alba X S. fragilis
Tihanyi Z. et al. 72

S. alba cv. 'Sekocin'
Jezewski Z. et al. 74

S. alba Valenza I-1/59
Tsanov Ts. I. 78

S. americana daphnoides
Iliev S. 73

S. americana X S. daphnoides
Tsanov Ts. I. 74

S. 'Aquatica Gigantea'
Pohjonen V. 74

S. caprea
Sidorov A.I. 77

S. cinerea
Iliev S. 73
Sidorov A.I. 77

S. exigua
Geyer W.A. 81

S. fragilis
Iliev S. 73

S. phylicifolia
Pohjonen V. 74

S. triandra
Tsanov Ts. I. 74

S. viminalis
Iliev S. 73
Tsanov Ts. I. 74

S. viminalis X S. purpurea
Tsanov Ts. I. 74

Scleronema micranthum
Schmidt P.B. et al. 72

Tabebuia vellosoi
Nogueira J.C.B. et al. 76

Taiwania cryptomerioides
Lin W.C. 75

Tectona grandis
Bunvong Thaiutsa et al. 76
Garcia C.J.R. 73
Watterston K.G. 71

T. tanimbouca
Schmidt P.B. et al. 72

Thuja plicata
Smith J.H.G. 80

Tilia spp.

T. argentea
Dimitrov Kh. et al. 79

T. cordata
Koss H. et al. 82

T. tomentosa
Lyapova I. 80

Tipuana tipu
Herrera J.C. 71

Toona australis
Wick H.L. et al. 71

Tsuga heterophylla
Cruwys G.E. 72
Lin J.Y-H. 70
Smith J.H.G. 76,80

Ulmus spp.

U. americana
George E.J. et al. 73

U. pumila
Dimitrov Kh. et al. 79

U. pumila var. arborea
Torokhtun I.M. 81

SUBJECT INDEX

CHRISTMAS TREES
Gramada S. et al. 72
Recklinghausen H. Von 81
Vakulyuk P.G. et al. 80

COST AND/OR RETURNS
Acosta Romero R. 76
Aliev Sh. 75
André P. 76,78
Anon. 72a
Beck O.A. 81
Bella I.E. 74
Bennett F.A. 71
Berben J.C. 78
Branbander H.D. et al. 76
Brett P. et al. 78
Cook D.B. 74
Crowther R.E. 77
Cruwys G.E. 72
Dagenbach H. 78
Dittmar O. et al. 74
Dutrow G.F. 71
Edwards P.N. et al. 79
Elgueta Salinas H. et al. 71
Erken T. 72
Fishwick R.W. 76
Fromsdorf U. et al. 80
Gallagher G.J. et al. 80
Gouttin P. 74
Gramada S. et al. 72
Halupa L. 72
Incoll W.D. et al. 79
Jacquemin A. 73
Johann K. et al. 74
Kantemirov Z. Kh. 75
Kern K.G. 73
Kohan S. 73
Kramer H. 75,80a
Kramer H. et al. 77
Kuzmanovic U. 73
Lin W.C. 75
Low A.J. 74
Mann W.F. Jr. et al. 77
Mello H.A. et al. 72
Meyer R. 75
Moller C.M. 73
Mrazek F. 79
O'Brien D. 80
O'Flanagan L.P. 80
Polge H. 76
Pollanschutz J. 74a
Proni G. et al. 74,79a,79b
Recklinghausen H. Von 81
Reukema D.L. 79
Schonau A.P.G. 74
Shinkaruk A.I. 75
Singh R.V. 77
Smith J.H.G. 71
Stern R.C. 72
Stoiculescu C.D. 73b
Stredicke R. 77
Tarasenko V.P. et al. 71
Thomasius H. 74,75
Vakulyuk P.G. et al. 80
Vlaheli I. et al. 74
Westra J.J. 75

DATA
Acosta Romero R. 76
Bartoli M. 71
B''Chvarov D. et al. 72
Borough C.J. 78
Boudru M. 76
Bozhko V.E. 74
Dekanic I. 73
Dotsenko A.P. 81
Eccher A. 73
Enghardt H.G. et al. 72
Fakirov V. 76b
Fonseca J.M.M.A. et al. 74
Frison G. 79,80
Garcia C., J.R. 73
Gathy P. 75
Giordano E. et al. 79
Grigor'ev V.P. et al. 78
Ivanov S.M. 74
Kairyukshtis L.A. et al. 75
Kuzmanovic U. 73
Kuz'michev V.V. et al. 79
Lyapova I. 80
Markovic J. 73
Mitirev A.E. et al. 76
Naidenova-Yaneva Ts. 73
Ovcharov G. 75
Pedroso L.M. et al. 71
Pinchuk A.M. et al. 73
Pirtskhalaishvili S. Kh. et al. 75
Pisarenko A.I. et al. 79
Pulinets M.P. 81
Quaynor S. O-A. 71
Rocuant Trucios L. 78
Sancho R. et al. 72
Santander Flores C. et al. 74
Sato S. 72a
Savina A.V. et al. 78
Schmidt P.B. et al. 72
Shinkarenko I.B. et al. 76
Shinkaruk A.I. 75
Simoes J.W. et al. 70
Smirnov N.A. 75
Smith J.H.G. 71
Stepanov L.I. 75
Stiell W.M. et al. 77
Timofeev V.P. 74
Tyshkevich G.L. 76
Ul'yanov V.I. 81
Utkin A.I. et al. 80
Volpato E. et al. 73
Vyskot M. 78
Walters G.A. 80
Wick H.L. et al. 71
Zhuravleva M.V. et al. 81

EXPERIMENTAL DESIGNS/ RESEARCH METHODS
Abetz P. 71,73
Alder D. 79
Borough C.J. 78
Bunvong Thaiutsa et al. 76
Burgers T.F. 71
Burschel P. et al. 74
Cox F. 71
Cruwys G.E. 72
Decourt N. et al. 74
Delwaulle J.C. 79
Dunsworth B.G. et al. 80
Ek A.R. et al. 76a,76b
Eriksson L. 77
Gurgel Filho O.A. 73
Johann K. et al. 74,80
Kairyukstis L.A. et al. 75
Kihlstock N. et al. 79
Laar A. Van 78
Laar A. Van et al. 79
Lin J. Y.-H. 70
Lundgren A.L. 81
Onis'kiv N.I. 72
Pande G.C. 74

Rocuant Trucios L. 78
Schlaegel B.E. 81
Smith J.H.G. 78
Solymos R. 70
Stoiculescu C.D. 74
Thomasius H. 72,75
Thomasius H.O. et al. 78
Tomazius Kh. O. 78
Wiant H.V. Jr. 73
Yang Y.C. et al. 76
Zhelev I. 71

FOREST PROTECTION
Belyi G.D. 75
Belyi G.D. et al. 80
Bowersox T.W. et al. 76
Brammanis L. 75
Dittmar O. et al. 74
Edwards P.N. et al. 79
Eriksson L. 77
Gilliland J. 80
Hochmut R. et al. 74
Koch H. 77
Kohán Š. 73
Kramer H. 80
Ladrach W.E. 74
Lewis C.E. et al. 72
Lisbão Junior L. 80
May J.T. et al. 73
Meyer R. 75
Mráček Z. 80
Mulder D. 79
Neary D.G. et al. 74
Netrebenko V.G. et al. 76
O'Flanagan L.P. 80
Palit S. 80
Parrot L. 71
Sarigumba T.I. et al. 79
Schipper A.L. Jr. 76
Schmidt W.C. 78
Vakurov A.D. 79
Vyskot M. 78
Westra J.J. 75

GENERAL
Bhatia K.S. 80
Bondarenko V.D. 76
Chroust L. 73
Elgueta Salinas H. et al. 71
Evert F. 73
Il'inskii V.D. et al. 75
Kilpatrick D.J. et al. 81
Low A.J. et al. 75
Pan C.S. 74
Piene H. 78
Pisarenko A.I. et al. 78
Prevosto M. et al. 80
Sato S. 72a,73
Strong T.F. et al. 78
Torokhtun I.M. 81
Weihe J. 76,78

LOGGING REQUIREMENTS
Bonduelle P. 78
Crowther R.E. 77
Gibson G.E. et al. 77
Kramer H. et al. 77

REVIEWS
Beck O.A. 81
Belyi G.D. 75
Burschel P. 81
Cox F. 71
Delvaux J. 75,81
Kramer H. 75
Pisarenko A.I. et al. 79
Zajaczkowski J. 73
Zhelev I. 76
Zimmermann H. 82

SILVICULTURAL CONSIDERATIONS
Anon. 72b
Aussenac G. 79
Barrett J.W. 70
Been A. 72
Bergel D. 73
Boudru M. 76
Chavasse C.G.R. et al. 81
Curtis R.O. et al. 74
Dohrenbusch A. et al. 81
Edwards P.N. et al. 79
Frison G. 74
Gilliland J. 80
Gilmore A.R. 78
Gouttin P. 74
Jezewski Z. et al. 74
Kloosterhuis W.E.H. 76
Konnert V. 74
Koss H. et al. 82
Lynch T.J. 80
Martin B. 70
Meyer R. 75
O'Brien D. 80
O'Flanagan L.P. 80
Pardé J. 78
Pirtskhalaishvili S. Kh. et al. 75
Romanov A.P. 75
Wick H.L. et al. 71
Zavitkovski J. 81

Cone production
Hattemer H.H. et al. 77

Efficiency of needles
Popov V.K. et al. 81

Fertilizing
Belyi G.D. et al. 80
Berben J.C. 75
Brammanis L. 75
Denev D.A. 74
Donald D.G.M. et al. 77
Dotsenko A.P. 81
Francis J.K. 77
Frison G. 76
Hattemer H.H. et al. 77
Haverbeke D.F. Van 77
Heilman P.E. et al. 72
Hochmut R. et al. 74
Hoyle M.C. 75
Husain A.M.M. et al. 80
Jezewski Z. et al. 74
Lear D.H. Van et al. 73
Lisbão Junior L. 80
Mello H.A. et al. 70
Mendoza V.B. et al. 76
Menetrier J. 78
Nogami K. 74
Nostrand R.S. Van 75
Sheedy G. 78
Simoes J.W. et al. 70
Tölle H. 76
Veiga A. de A. 73
Wood B.W. et al. 77

Flowering
Freitas E.R. de et al. 72

Machine planting
Brabander H.D. et al. 76
Incoll W.D. et al. 79
Netrebenko V.G. et al. 76

Mechanical tending
Berenhauser H. 71
Botenkov V.P. 79
Dagenbach H. 78
Delvaux J. 75
Eriksson L. 77
Jeschke S. 77
Kohlstock N. et al. 79
Leek N.A. 80
Lewis C.E. et al. 72
Moore D.G. 73
Netrebenko V.G. et al. 76
Streyffert T. 79
Tyshkevich G.L. 76
Vlaheli I. et al. 74
Zimmermann H. 82

Pruning
Beck O.A. 81
Boudru M. 76
Choong E.T. et al. 74
Clark P.M. et al. 79
Dearborn M. 76
Erteld W. 75
Fromsdorf U. et al. 80
Garavel L. 72
Gardiner J.J. et al. 78
Garia S., J. et al. 78
Hoyle M.C. 75
Kramer H. et al. 78
O'Flanagan L.P. 80
Orlic S. 71
Oswald H. et al. 76
Polge H. 76
Recklinghausen H. Von 81
Sakss K. et al. 69
Schonau A.P.G. 74
Streyffert T. 79
Sutton W.R.J. 71
Wick H.L. et al. 71

Recommended spacing
Aliev Sh. 75
Andre P. et al. 75
Assmann E. 75
Balmer W.E. et al. 75
Beck O.A. 81
Belanger R.P. et al. 78
Bella I.E. et al. 80
Berenhauser H. 71
Bondarenko N. Ya. et al. 72
Bozhko V.E. 74
Brabander H.D. et al. 76
Couto H.T.Z. et al. 73
Delvaux J. 81
Dimitrov Kh. et al. 79
Dyson W.G. 74
Elgueta Salinas H. et al. 71
Fakirov V. 72a,72b
Fromsdorf U. et al. 80
Garavel L. 72
Garia S., J. et al. 78
Gathy P. 75
Gibson G.E. et al. 77
Gurgel Filho O.A. 75
Hapla F. 81
Haverbeke D.F. Van 77
Hyun S.K. et al. 74
Iliev A. et al. 75
Jacquemin A. 73
Kenk G. et al. 80
Khizhnyak N.I. 74
Kim S.I. et al. 76
Kohlstock N. et al. 79
Koss H. et al. 82
Krinard R.M. et al. 75
Ladrach W.E. 74
Larin V.B. et al. 72
Lin W.C. 75
Low A.J. 74
Mello H.A. et al. 71
Morrow R.R. 78
Mráček Z. 70,80
Mülder D. 79
Nogueira J.C.B. et al. 76
Onis'kiv N.I. 72
Orlic S. 73
Penafiel S.R. 73
Recklinghausen H. Von 81
Sakamoto T. 69
Saradzhishvili D.G. 76
Sarigumba T.I. et al. 79
Savina A.V. et al. 78
Schipper A.L. Jr. 76
Sheikh M.I. 80
Shinkaruk A.I. 75
Singh R.V. 77
Smirnov N.A. 75
Solymos R. 75
Thomasius H. 74
Tsanov Ts. I. 74,78
Vakurov A.D. 79
Vashchenko I.M. 79
Vries P.G. de et al. 78
Vyskot M. 78
Walters G.A. 80
Whitmore J.L. et al. 80
Wick H.L. et al. 71
Williston H.L. 78,79
Yurov I.V. 75
Zakhariev B. et al. 80

Root Systems
B''Chvarov D. 80
Bondarenko N. Ya. et al. 72
Dohrenbusch A. et al. 81
Gilmore A.R. 78
Shinkarenko I.B. et al. 76
Tyshkevich G.L. 76

Rotation
Bonduelle P. 77
Bradander H.D. et al. 76
Coelho A.S.R. et al. 70
Crowther R.E. 77
Dyson W.G. 74
Frison G. 74
Geyer W.A. 78
Gibson G.E. et al. 77
Gilliland J. 80
Gilmore A.R. 78
Gilmore A.R. et al. 74
Heilman P. et al. 72,81
Heilman P.E. et al. 72
Kennedy H.E. Jr. 75
Kolster H.W. et al. 74,75
Kolster K.W. et al. 79
Kuzmanovic U. 73
Lynch T.J. 80
Ménétrier J. 78
Moore D.G. 73
Mugasha A.G. 78b
O'Flanagan L.P. 80
Osterhaus C.A. et al. 78

Poynton R.J. 81
Proni G. et al. 74
Sancho R. et al. 72
Saucier J.R. et al. 72
Sertmehmetoglu Z. et al. 72
Singh R.V. 77
Steinbeck K. et al. 72
Stern R.C. 72
Tarasenko V.P. et al. 71
Wittwer R.F. et al. 78
Wood B.W. et al. 76
Zavitkovski J. et al. 78
Zhelev I. 76

Seed yield
Botenkov V.P. 79
Freitas E.R. de et al. 72
Parrot L. 71
Sidorov A.I. 77
Streyffert T. 79

Selection possibilities
Ben Salem B. 75
Campbell R.K. 73
Delvaux J. 75,81
Moore D.G. 73
Parrot L. 71

Site
Abetz P. 73
Aliev Sh. 75
André P. et al. 72
Anon. 72a
Assmann E. 75
Belanger R.P. et al. 78
bella I.E. 74
Bella I.E. et al. 74
Berben J.C. 75
Botenkov V.P. 79
Boudru M. 76
Brasil M.A.M. et al. 71
Chistyakov A.R. et al. 79
Dagenbach H. 78
Delvaux J. 73
Denev D.A. 74
Dittmar O. 75,77
Ek A.R. et al. 76a
Fakirov V. 72b,76a,76b
Feduccia D.P. et al. 76
Fishwick R.W. 76
Flöhr W. 75
George E.J. et al. 73
Gibson G.E. et al. 77
Hallik J. 77
Halupa L. et al. 75
Hasan S.M. et al. 80
Hopkins E.R. 71
Hoyle M.C. 75
Hyun S.K. et al. 74
Karani P.K. 76
Kolster H.W. 78
Konnert V. 74
Korobov I.A. 78
Kramer H. 75
Lewis C.E. et al. 72
Low A.J. 74
May J.T. et al. 73
McClurkin D.C. 76
McKinnell F.H. 71
Mello H.A. et al. 70,76
Merzlenko M.D. 74
Meyer R. 75
Moller C.M. 73
Mrazek F. 79
Mühle O. et al. 72,79
Orlic S. 73
Osterhaus C.A. et al. 78
Palashev I. et al. 73
Pande G.C. 74
Piskun B. 72b
Prokop'ev M.N. 76
Ryabokon' A.P. 79
Sancho R. et al. 72
Saradzhishvili D.G. 76
Schonau A.P.G. 74
Sharma R.P. 78
Sheedy G. 78
Shim P.S. 73
Shinkarenko I.B. et al. 76
Shinkaruk A.I. 75
Simoes J.W. et al. 70
Smirnov N.A. 75
Smith J.H.G. 80
Stoiculescu C.D. 73a,73b
Thomasius H. 74
Tihanyi Z. et al. 72
Tsanov Ts. I. 74
Ul'yanov V.I. 81
Vashchenko I.M. 79
Watterston K.G. 71
Whitmore J.L. et al. 80
Wick H.L. et al. 71
Williston H.L. 78,79
Wittwer R.F. et al. 78
Wood B.W. et al. 76,77
Yurov I.V. 75
Zakhariev B. et al. 75
Zavitkovski J. et al. 81
Zhelev I. 76
Zhuravleva M.V. et al. 81
Zimmermann H. 82

Site preparation
Belyi G.D. et al. 80
Endean F. et al. 72
Sarigumba T.I. et al. 79
Smirnov N.A. 75

Spacing practices
Edwards P.N. et al. 79
Gilliland J. 80
Ipatov L.F. 80
Onis'kiv N.I. 72
Shapland R.E. 74

Thinning
Abetz P. 74,76
Adlard P.G. et al. 74
André P. 76,78
Assman E. 75
Babenko D.K. et al. 75
Barrett J.W. 72
B''Chvarov D. 80
Bella I.E. 74
Bennett F.A. 71
Berry A.B. 74
Borota J. 71
Boudru M. 76
Bozhko V.E. 74
Brett P. et al. 78
Burns R.M. et al. 78
Burschel P. 81
Burshel P. et al. 74
Carretero R.V. 72
Chamshama S.A.O. et al. 80
Chistyakov A.R. et al. 79
Choong E.T. et al. 74
Chroust L. 73
Cruwys G.E. 72
Decei I. et al. 80
Delvaux J. 70,75
Dik E.J. 75
Dittmar O. et al. 74
Divoux A. et al. 80

Dotsenko A.P. 81
Eccher A. 74,75
Enghardt H.G. et al. 72
Eriksson L. 77
Faber P.J. 78
Fakirov V. 80
Fishwick R.W. 76
Fromsdorf U. et al. 80
Gallagher G.J. et al. 80
Garcia C., J.R. 73
Garia S., J. et al. 78
Giordano E. et al. 79
Grigor'ev V.P. et al. 78
Gurgel Filho O.A. 73a,73b
Halupa L. 72
Halupa L. et al. 75
Hopkins E.R. 71
Hoyer G.E. et al. 76
Johann K. et al. 74
Karani P.K. 76
Kohlstock N. et al. 79
Korobov I.A. 78
Kramer H. 75,80b,80c
Kramer H. et al. 77,78
Krinard R.M. et al. 75,80
Ladrach W.E. 74
Lepekhin A.V. 81
Lohrey R.E. 72
Lundgren A.L. 81
Lynch T.J. 80
Mann W.F. Jr. et al. 72,77
Martynov A.N. 77
Massinet S. du 75
McKinnell F.H. 71
Mitirev A.E. et al. 76
Morrow R.R. 74,78
Mugasha A.G. 78
O'Brien D. 80
O'Flanagan L.P. 80
Oswald H. et al. 76
Phipps H.M. 73
Piene H. 78
Polge H. 76
Popov V.K. 80
Proni G. et al. 79a,79b
Reukema D.L. 79
Rocuant Trucios L. 78
Ryabokon' A.P. 79
Schultz R.P. 72
Siemon G.R. et al. 76
Simoes J.W. et al. 74
Stoiculescu C.D. 73a,73b,74
Stoiculescu D.C. 73
Stredicke R. 77
Streyffert T. 79
Szodfridt I. 72
Ul'Yanov V.I. 81
Vakulyuk P.G. et al. 80
Veldhoen B.J. 70
Vries P.G. de et al. 78
Whitesell C.D. 75
Williston H.L. 78,79
Yang Y.C. 72
Zimmermann H. 82

Weeds
Bergmann J.H. et al. 77
Botenkov V.P. 79
Crowther R.E. 77
Dearborn M. 76
Endean F. et al. 72
Haron B. Hj. Abu Hassan 76
Heilman P.E. et al. 72
Hoyle M.C. 75
Jeschke S. 77
Jezewski Z. et al. 74
Martynov A.N. 77
Mendoza V.B. et al. 76
Mühle O. et al. 72

SUGARBUSH STOCKING
Lancaster K.F. et al. 74

TABLES
André P. et al. 72
Delvaux J. 74
Escobar R., R. et al. 76
Frison G. 79
Gurgel Filho O.A. 73
Kairyukshtis L.A et al. 75
Mann W.F. Jr. 71
Mann W.F. Jr. et al. 71,72
Martin B. 70
Parde J. 78
Sharma R.P. 78,79
Thomasius H. 74
Ul'yanov V.I. 81a
Veiga A. de A. 73

TIMBER QUALITY
Andre P. 78
Andre P. et al. 72
Angel Menéndez M. 71
Barse R.G. et al. 80
B''Chvarov D. 80
Berben J.C. 78
Bonduelle P. 78
Burschel P. 81
Cesar S.F. 77
Crist J.B. et al. 75
Delvaux J. 75
Dittmar O. 77
Dotsenko A.P. 81
Edwards P.N. et al. 79
Feduccia D.P. et al. 76
Fishwick R.W. 76
Giordano E. et al. 79
Gurgel Filho O.A. 73
Kramer H. 75,80a
Krinard R.M. et al. 75
Lundgren A.L. 81
Massinet S. Du 75
Meskimen G. 78
Morrow R.R. 78
Mráček Z. 70,80
Mugasha A.G. 78
Murphey W.K. et al. 77
Nekhaichuk O.G. et al. 79
Nikolov S. et al. 79
O'Brien D. 80
Oosterbaan A. 81
Parrot L. 71
Persson A. 75a,75b,76,77
Polge H. 76
Pollanschutz J. 74a
Shapland R.E. 74
Smith J.H.G. 76
Wearstler K.A. Jr. 79
Westra J.J. 75
Wick H.L. et al. 71

Branch and crown development
Babenko D.K. et al.75
B''Chvarov D. 80
Beck O.A. 81
Bella I.E. et al. 74,80
Braastad H. 79
Cesar S.F. 77
Day R.J. et al. 70
Dittmar O. et al. 74
Donald D.G.M. et al. 77
Dozsa J. 74
Elfving B. 75
Erteld W. 75
Fromsdorf U. et al. 80

Gurgel Filho O.A. 75
Hattemer H.H. et al. 77
Haveraaen O. 81
Kenk G. et al. 80
Kern K.G. 73
Kostov K.D. 75
Kramer H. et al. 78
Lemoine B. 80
Markovic J. 74,75
Moore D.G. 73
Mühle O. et al. 79
Nelson N.D. et al. 81
Netrebenko V.G. et al. 76
Piskun B. 72a
Prado Donoso J.A. et al. 79
Razin G.S. 79
Santander Flores C. et al. 74
Sato S. 72b
Schuster C. 78
Shinkarenko I.B. et al. 76
Siemon G.R. et al. 76
Singh R.V. 77
Smith J.H.G. 76,80
Stepanov L.I. 75
Stiell W.M. 69
Stiell W.M. et al. 77
Stoiculescu C.D. 74
Sutton W.R.J. 71
Vyskot M. 78
Zhelev I. 76

Crookedness
Heilman P.E. et al. 79
Mülder D. 79

Extractive content
Persson A. 75b
Fiber dimensions
Goo M. 71
Markovic J. 74,75
Nekhaĭchuk O.G. et al. 79
Persson A. 75b
Pinchuk A.M. et al. 73
Tekhneryadnov A.V. et al. 73

Form and taper
Adlard P.G. et al. 74
Andrē P. 76
Bella I.E. et al. 80
Hamilton G.J. et al. 74
Hannelius S. 78
Koss H. et al. 82
Morrow R.R. 74,78
Mühle O. et al. 79
Piskun B. 72b
Sutton W.R.J. 71

Knots
Laidly P.R. et al. 79
Persson A. 75a
Sutton W.R.J. 71

Latewood percent
Hapla F. 81
Lear D.H. Van et al. 73
Nekhaĭchuk O.G. et al. 82
Nikolov S. et al. 79
Pinchuk A.M. et al. 73
Smith J.H.G. 76,80
Tekhneryadnov A.V. et al. 73

Resistance to Fungus

Self-Pruning
Dearborn M. 76
Giordano E. et al. 79
Oosterbaan A. 81
Oswald H. et al. 76
Piskun B. 72a
Vyskot M. 78

Spiral Grain

Stem Excentricity
Stoiculescu D.C. 73

Wood Density
Brasil M.A.M. et al. 71
Dawson D.H. et al. 76
Ferrari G. et al. 79
Gardiner J.J. et al. 78
Geyer W.A. 81
Montagna R.G. et al. 73
Ward D. et al. 76

TREE AND STAND DEVELOPMENT

Biomass
Frison G. 74
Mühle O. et al. 72
Pinchuk A.M. et al. 73
Wittwer R.F. et al. 78
Wood B.W. et al. 77
Zavitkovski J. 76,81
Zavitkowski J. et al. 78
Zavitkovski J. et al. 81

Dry Matter and Weight
Coelho A.S.R. et al. 70
Crist J.B. et al. 75
Dawson D.H. et al. 76
Ek A.R. et al. 76b
Hapla F. 81
Madgwick H.A.I. 81
Mello H.A. et al. 71
Stiell W.M. 69
Wada K. et al. 72
Wang T.T. 77
Wood B.W. et al. 76
Zavitkovski J. 81
Zavitkowski J. et al. 77
Zavitkovski J. et al. 81

Fresh Weight
Belanger R.P. et al. 78
Frison G. 79,80
Heilman P.E. et al. 72
Kim D.C. et al. 74
Pohjonen V. 74
Wang T.T. 77
Wittwer R.F. et al. 78
Wood B.W. et al. 76

Growth and Yield
Abetz P. 71
Aliev Sh. 75
Andrē P. et al. 72
Anon 72
Arnold L.E. 78
Barannik A.B. 78
Barrett J.W. 72
Berben J.C. 78
Bozhko V.E. 74
Braastad H. 79
Bredenkamp B. 80
Campbell R.K. et al. 73
Carretero R.V. 72
Coelho A.S.R. et al. 70
Couto H.T.Z. et al. 73
Cozzo D. 74
Crist J.B. et al. 75
Decei I. et al. 80

Delvaux J. 73
Denev D.A. 74
Dimitrov Kh. et al. 79
Dittmar O. 75,77
Dittmar O. et al. 74
Dyson W.G. 74
Ek A.R. et al. 76a,76b
Evans J. 76
Faber P.J. 78
Fakirov V. 72a,72b,76a,76b
Flöhr W. 75
Francis J.K. 77
Frison G. 74
Ganchev A. et al. 71
Geyer W.A. 78,81
Gizatullin S. Kh. 73
Gomis H. 74
Hannelius S. 78
Harms W.R. et al. 81
Haron B. Hj. Abu Hassan 76
Hasan S.M. et al. 80
Heilman P.E. et al. 72,81
Hopkins E.R. 71
Hyun S.K. et al. 74
Ivanov S.M. 74
Jacquemin A. 73
Kennedy H.E. Jr. 75
Kim D.C. et al. 74
Kim S.I. et al. 76
Kohán Š. 73
Krasnyatov V.V. 81
Krinard R.M. 71
Kuzmanovic U. 73
Lewis C.E. et al. 72
Lundgren A.L. 81
Mann W.F. Jr. et al. 77
Martin B. 70
McKinnel F.H. 71
Mello H.A. et al. 70,71,76
Meskimen G. et al. 78
Mitchell K.J. 78
Molino O. 72,78
Morrow R.R. 78
Mugasha A.G. 78
Naĭdenova-Yaneva Ts. 73
Nekhaichuk O.G. et al. 79
Netrebenko V.G. et al. 76
Oliver W.W. 79
Ovcharov G. 75
Parrot L. 71
Pedroso L.M. et al. 71
Persson A. 75b
Pohjonen V. 74
Pollanschutz J. 74a,74b
Prado D. J.A. et al. 79
Prokop'ev M.N. 76
Reukema D.L. 79
Sakss K. et al. 69
Sarigumba T.I. et al. 79
Saucier J.R. et al. 72
Schmidt W.C. 78
Schuster C. 78
Sharma R.P. 78,79
Shim P.S. 73
Sidorov A.I. 77
Steinbeck K. et al. 72
Stoiculescu C.D. 73a,73b,74
Szodfridt I. 72
Tarasenko V.P. et al. 71
Thomasius H. 75
Timofeev V.P. 74
Tolkachev L.N. 76
Tsanov Ts. I. 74
Ul'yanov V.I. 81a,81b
Utkin A.I. et al. 80
Walters G.A. 80
Wick H.L. et al. 71
Williston H.L. 78,79
Wittwer R.F. et al. 78
Wood B.W. et al. 76,77
Yurov I.V. 75
Zhuravleva M.V. et al. 81

Mortality and Survival

Anon. 72a
Arnold L.E. 78
Balmer W.E. et al. 75
Barangan F. 78
Barannik A.B. 78
Bella I.E. et al. 80
Berben J.C. 75
Botenkov V.P. 79
Brandi R.M. et al. 77
Burns R.M. et al. 78
Cesar S.F. 77
Couto H.T.Z. et al. 73
Dittmar O. et al. 74
Endean F. et al. 72
Fishwick R.W. 76
Fonseca J.M.M.A. et al. 74
Gizatullin S. Kh. 73
Gomis H. 74
Hallik J. 77
Hamilton G.J. et al. 74
Haverbeke D.F. Van 77
Heilman P.E. et al. 72
Hoyer G.E. et al. 76
Iliev S. 73
Ipatov L.F. 80
Jakobsen B. 79
Khizhnyak N.I. 74
Kolster H.W. et al. 74,75
Kramer W. 80
Krinard R.M. et al. 80
Larin V.B. et al. 72
Leikola M. et al. 77
Lemoine B. 80
Lewis C.E. et al. 72
Lisbão Junior L. 80
Maun M.M. 77
Maun M.M. et al. 72
McClurkin D.C. 76
Mendoza V.B. et al. 76
Mühle O. et al. 72,79
Netrebenko V.G. et al. 76
Osterhaus C.A. et al. 78
Oswald H. 80
Parviainen J. 79
Santander Flores C. et al. 74
Sarigumba T.I. et al. 79
Sazon A.C. 72
Schonau A.P.G. 74
Schultz R.P. 72
Sheikh M.I. 78
Thomasius H. 74,75
Ul'yanov V.I. 81
Vakurov A.D. 79
Vlaheli I. et al. 74
Wada K. et al. 72
Whitesell C.D. 74
Whitmore J.L. et al. 80
Wick H.L. et al. 71
Williston H.L. 79
Wittwer R.F. et al. 78
Wood B.W. et al. 76
Yurov I.V. 75
Zavitkovski J. 81
Zavitkowski J. et al. 77

STEM DIMENSIONS

Basal Area

Abetz P. 76

Adlard P.G. et al. 74
André P. 78
André P. et al. 75
Barangan F. 78
Bella I.E. et al. 80
Braastad H. 79
Burns R.M. et al. 78
Delvaux J. 75
Dittmar O. 77
Divoux A. et al. 80
Elfving B. 75
Fakirov V. 76b,80
Frison G. 76
Fromsdorf U. et al. 80
Garcia C., J.R. 73
Garia S., J. et al. 78
Griess O. 79
Hamilton G.J. et al. 74
Hannelius S. 78
Harms W.R. et al. 81
Karani P.K. 76
Kramer H. et al. 78
Litvak P.V. et al. 77
Mann W.F. Jr. 71
Mann W.F. Jr. et al. 71,77
McClurkin D.C. 76
Morrow R.R. 78
Oswald H. 80
Phipps H.M. 73
Piene H. 78
Prado Donoso J.A. et al. 79
Sharma R.P. 78,79
Stiell W.M. 69
Vyskot M. 78
Wada K. et al. 72
Whitesell C.D. 74
Whitmore J.L. et al. 80
Williston H.L. 78
Yang Y.C. 72

Diameter
Abetz P. 76
Adlard P.G. et al. 74
Angel Menéndez M. 71
Arnold L.E. 78
Atamanyuk YU. A. 71
Balmer W.E. et al. 75
Barangan F. 78
Barrett J.W. 70
B''Chvarov D. 80
Belanger R.P. et al. 78
Bella I.E. et al. 74
Berben J.C. 75
Berry A.B. 74
Bosch R. 81
Braastad H. 79
Brandi R.M. et al. 77
Bredenkamp B. 80
Choong E.T. et al. 74
Clark P.M. et al. 79
Coelho A.S.R. et al. 70
Couto H.T.Z. et al. 73
Decei I. et al. 80
Delvaux J. 70,71
Divoux A. et al. 80
Dohrenbusch A. et al. 81
Eccher A. 74
Ek A.R. et al. 76a
Elfving B. 75
Erteld W. 75
Faber P.J. 77
Fakirov V. 80
Feduccia D.P. et al. 76
Fonseca J.M.M.A. et al. 74
Frison G. 79
Fromsdorf U. et al. 80
Garia S., J. et al. 78
George E.J. et al. 73
Griess O. 79
Gurgel Filho O.A. 73,75
Gurgel Filho O.A. et al. 73
Hamilton G.J. et al. 74
Hannelius S. 78
Hapla F. 81
Harms W.R. et al. 81
Hattemer H.H. et al. 77
Haveraaen O. 81
Heilman P.E. et al. 79
Jezewski Z. et al. 74
Johann K. et al. 74
Kantemirov Z. Kh. 75
Karani P.K. 76
Kim D.C. et al. 74
Koch H. 77
Kolster H.W. 78
Korobov I.A. 78
Koss H. et al. 82
Kramer H. 80c
Kramer H. et al. 78
Krasnyatov V.V. 81
Krinard R.M. et al. 75,80
Kuz'michev V.V. et al. 79
Lear D.H. Van et al. 73
Lin W.C. 75
Mann W.F. Jr. et al. 71, 77
Markovic J. 73
Maun M.M. 77
May J.T. et al. 73
McClurkin D.C. 76
Mendoza V.B. et al. 76
Montagna R.G. et al. 73
Moore D.G. 73
Morrow R.R. 78
Mugasha A.G. 78
Mülhe O. et al. 72,79
Netrebenko V.G. et al. 76
Orlic S. 71,73
Orlova N.A. 73
Panetsos C.P. 80
Parviainen J. 79
Penafiel S.R. 73
Pinchuk A.M. et al. 73
Piskun B. 72b
Prado Donoso J.A. et al. 79
Reukema D.L. 79
Santander F.C. et al. 74
Sarigumba T.I. et al. 79
Sato S. 72b
Schmidt P.B. et al. 72
Schuster C. 78
Sharma R.P. 78,79
Sheikh M.I. 78
Simoes J.W. et al. 70
Singh R.V. 77
Stiell W.M. et al. 77
Szodfridt I. 72
Tolkachev L.N. 76
Tyshkevich G.L. 76
Volpato E. et al. 73
Vyskot M. 78
Wada K. et al. 72
Walters G.A. 73,80
Whitesell C.D. 74
Whitmore J.L. et al. 80
Williston H.L. 78
Wittwer R.F. et al. 78
Zavitkovski J. 81
Zavitkowski J. et al. 77
Zhuravleva M.V. et al. 81

Height
Abetz P. 76
Acosta Romero R.76

André P. et al. 75
Anon. 71b
Arnold L.E. 78
Atamanyuk Yu. A. 71
Balmer W.E. et al. 75
Barangan F. 78
Barannik A.B. 78
Barrett J.W. 70
Bartoli M. 71
B''Chvarov D. 80
Beck O.A. 81
Belanger R.P. et al. 78
Bella I.E. et al. 74,80
Belyi G.D. et al. 80
Berben J.C. 75
Bosch R. 81
Botenkov V.P. 79
Boudru M. 76
Bowersox T.W. et al. 76
Braastad H. 79
Brandi R.M. et al. 77
Brasil M.A.M. et al. 71
Clark P.M. et al. 79
Coelho A.S.R. et al. 70
Dawson D.H. et al. 76
Decei I. et al. 80
Delvaux J. 70,71,75
Divoux A. et al. 80
Dohrenbusch A. et al. 81
Eccher A. 74
Ek A.R. et al. 76a
Elfving B. 75
Endean F. et al. 72
Faber P.J. 77
Fakirov V. 76b,80
Fonseca J.M.M.A. et al. 74
Francis J.K. 77
Frison G. 76,79
Garcia C., J.R. 73
George E.J. et al. 73
Gomis H.D. 73
Griess O. 79
Gurgel Filho O.A. 73a,75
Hamilton G.J. et al. 74
Hannelius S. 78
Harms W.K. et al. 81
Hasan S.M. et al. 80
Haveraaen O. 81
Haverbeke D.F. Van 77
Heilman P.E. et al. 72,79
Hoyle M.C. 75
Iliev S. 73
Jezewski Z. et al. 74
Johann K. et al. 74
Kantemirov Z. Kh. 75
Karani P.K. 76
Kim D.C. et al. 74
Koch H. 77
Kolster H.W. 78
Kolster H.W. et al. 74,75
Korobov I.A. 78
Koss H. et al. 82
Kramer H. et al. 78
Kramer W. 80
Krasnyatov V.V. 81
Krinard R.M. et al. 80
Lear D.H. Van et al. 73
Lemoine B. 80
Lin W.C. 75
Lisbão Junior L. 80
Markovic J. 73
Martynov A.N. 77
Maun M.M. 77
May J.T. et al. 73
McClurkin D.C. 76
Mendoza V.B. et al. 76
Meskimen G. et al. 78
Mrazek F. 79
Mugasha A.G. 78
Mülhe O. et al. 72,79
Netrebenko V.G. et al. 76
Nogueira J.C.B. et al. 76
Orlic s. 71,73
Orlova N.A. 73
Osterhaus C.A. et al. 78
Oswald H. 80
Panetsos C.P. 80
Parviainen J. 79
Penafiel S.R. 73
Piskun B. 72b
Pohjonen V. 74
Quaynor S. O-A. 71
Reukema D.L. 79
Romanov A.P. 75
Santander F.C. et al. 74
Sarigumba T.I. et al. 79
Schmidt P.B. et al. 72
Schultz R.P. 72
Schuster C. 78
Sharma R.P. 78
Sheikh M.I. 73,78
Simoes J.W. et al. 70
Smirnov N.A. 75
Stiell W.M. et al. 77
Szodfridt I. 72
Tyshkevich G.L. 76
Ul'yanov V.I. 81b
Volpato E. et al. 73
Vyskot M. 78
Wada K. et al. 72
Walters G.A. 73,80
Wearstler K.A. Jr. 79
Whitesell C.D. 74
Whitmore J.L. et al. 80
Wittwer R.F. et al. 78
Wood B.W. et al. 76
Zavitkowski J. et al. 77
Zhuravleva M.V. et al. 81

Volume

Abetz P. 76
Adlard P.G. et al. 74
André P. et al. 75
Angel Menéndez M. 71
Anon. 72b
Balmer W.E. et al. 75
Barrett J.W. 72
Bella I.E. et al. 80
Bennett F.A. 71
Berry A.B. 74
Bredenkamp B. 80
Burns R.M. et al. 78
Burschel P. 81
Cesar S.F. 77
Coelho A.S.R. et al. 70
Crowther R.E. 77
Dawson D.H. et al. 76
Day R.J. et al. 70
Dekanic I. 73
Delvaux J. 71,75
Dittmar O. 77
Eccher A. 73,74,75
Edwards P.N. et al. 79
Elfving B. 75
Erken T. 72
Evans J. 76
Faber P.J. 77,78
Fishwick R.W. 76
Frison G. 79,80
Fromsdorf U. et al. 80
Garcia C., J.R. 73
Garia S., J. et al. 78
Gibson G.E. et al. 77
Gilmore A.R. et al. 74
Goo M. 71

Gurgel Filho O.A. 73a,75
Gurgel Filho O.A. et al. 73
Hamilton G.J. et al. 74
Hannelius S. 78
Haveraaen O. 81
Haverbeke D.F. Van 77
Iliev A. et al. 75
Jezewski Z. et al. 74
Johann K. et al. 74
Kantemirov Z. Kh. 75
Kolster H.W. 78
Kolster K.W. et al. 79
Korobov I.A. 78
Krasnyatov V.V. 81
Krinard R.M. et al. 75,80
Kuzmanovic U. 73
Lemoine B. 80
Lin W.C. 75
Litvak P.V. et al. 77
Lynch T.J. 80
Mann W.F. Jr. 71
Mann W.F. Jr. et al. 72
May J.T. et al. 73
McClurkin D.C. 76
Mello H.A. et al. 76
Ménétrier J. 78
Merzlenko M.D. 74
Meskimen G. et al. 78
Mitirev A.E. et al. 76
Molino O. 72
Orlova N.A. 73
Oswald H. 80
Oswald H. et al. 76
Palashev I. et al. 73
Pande G.C. 74
Phipps H.M. 73
Pisarenko A.I. et al. 78
Piskun B. 72b
Polge H. 76
Pollanschutz J. 74a,74b
Prado Donoso J.A. et al. 79
Proni G. et al. 74
Reukema D.L. 79
Rockwood D.L. et al. 80
Sarigumba T.I. et al. 79
Schonau A.P.G. 74
Sharma R.P. 78
Shinkarenko I.B. et al. 76
Stoiculescu C.D. 73a,73b
Thomasius H. 74
Timofeev V.P. 74
Tölle H. 76
Vries P.G. de et al. 78
Vyskot M. 78
Walters G.A. 80
Whitmore J.L. et al. 80
Williston H.L. 78
Yang Y.C. 72
Zhuravleva M.V. et al. 81

CO-AUTHOR INDEX

Acar O. See Sertmehmetoglu Z. 72
Aeberli B.C. see Incoll W.D. 79
Aguiar I.B. see Fonseca J.M.M.A. 74
Aguirre A.J.J. see Prado Donoso J.A. 79
Aguirre A.J.J. see Prado Donoso J.A. 79
Al-Saraf M.J. see Hasan S.M. 80
Albertin W. see Santander Flores C. 74
Alekseev I.A. see Belyi G.D. 80
Anderson G.A. see Sarigumba T.I. 79
Andersson E. see Hattemer H.H. 77
Antoine R. see Andre P. 72
Araujo V.C. de see Volpato E. 73
Armasescu S. see Decei I. 80
Askarov K. ZH. see Tekhneryadnov A.V. 73
Avanzo E. see Giordano E. 79
Bakos V. see Ionescu A. 71
Baldwin R.C. see Murphey W.K. 77
Balneaves J.M. see Chavasse C.G.R. 81
Banders V. see Sakss K. 69
Barse K.G. see Laidly P.R. 79
Belyi G.D. see Vakulyuk P.G. 80
Benskin H. see Brett P. 78
Berger R. see Mello H.A. 72
Berger R. see Simoes J.W. 74
Berry A.B. see Stiell W.M. 77
Bertolani F. see Simoes J.W. 74
Birler A.S. see Sertmehmetoglu Z. 72
Bjerg N. see Kramer H. 77
Bjerg N. see Kramer H. 78
Bl'Skova G. see Nikolov V. 79
Blankenhorn P.R. see Murphey W.K. 77
Bobrov A.I. see Nekhaichuk O.G. 82
Bogdanov B. see Iliev A. 75
Borges C.P. see Freitas E.R. de 72
Bower R.C. see Dunsworth B.G. 80
Bowersox T.W. see Murphey W.K. 77
Bowles G.P. see Chavasse C.G.R. 81
Brasil U.M. see Mello H.A. 76
Bredenkamp B. see Laar A. Van 79
Brendemuehl R.H. see Burns R.M. 78
Brendemuehl R.H. see Rockwood D.L. 80
Broshchilov K. see Dimitrov KH. 79
Bryantseva Z.E. see Nekhaichuk O.G. 82
Burk T. see Nelson N.D. 81
Butoi V. see Gramada S. 72
Calderon Sanchez S. see Elgueta Salinas H. 71
Carpenter S.B. see Wood B.W. 76
Carpenter S.B. see Wood B.W. 77
Chae B.C. see Kim S.I. 76
Chang B.Y. see Choong E.T. 74
Chen C.M. see Yang Y.C. 76
Chkhaidze D.K. see Pirtskhalaishvili S.K. 75
Christie J.M. see Hamilton G.J. 74
Clark A. III see Saucier J.R. 72
Clayton J.M. see Wittwer R.F. 78
Coelho A.S.R. see Mello H.A. 72
Conde L.F. see Rockwood D.L. 80
Cooley J.H. see Godman R.M. 70
Corsini C.A. see Gurgel Filho O.A. 73
Couto H.T.Z. see Brandi R.M. 77
Couto H.T.Z. see Mello H.A. 70
Couto H.T.Z. see Mello H.A. 71
Couto H.T.Z. see Mello H.A. 72
Couto H.T.Z. see Simoes J.W. 70
Dawson D.H. see Crist J.B. 75
Dawson D.H. see Ek A.R. 76
Dawson D.H. see Ek A.R. 76
Dawson D.H. see Zavitkowski J. 77
Dawson D.H. see Zavitkowski J. 78
Day M.W. see Neary D.G. 74
DeBell D.S. see Heilman P.E. 72
Decei I., and S. Armasescu 80
Dell T.R. see Mann W.F. Jr. 71
Dias R.A. see Montagna R.G. 73
Duzan H.W. Jr. see Allen H.L. 81
Ekuan G. see Heilman P.E. 79
Enescu I. see Vlaheli I. 74
Enghardt H.G. see Mann W.F. Jr. 72
Ermolova L.S. see Utkin A.I. 80
Espinosa B.M. see Escobar R.R. 76
Eterevskaya L. see Bondarenko N.Y. 72
Evdokimov A.P. see Litvak P.V. 77
Feduccia D.P. see mann W.F. Jr. 77
Fernandes P.D. see Fonseca J.M.M.A. 74
Ferreira C.A. see Mello H.A. 76
Ferreira M. see Brasil M.A.M. 71
Ferreira M. see Freitas E.R. de 72
Fight R. see Curtis R.O. 74
Forrest W.G. see Siemon G.R. 76
Foulds R.T. see Lancaster K.F. 74
Franceschi J.P. de see Bella I.E. 74
Franceschi J.P. de see Bella I.E. 80
Frank A.B. see George E.J. 73
Franklin E.C. see Meskimen G. 78
Franz F. see Burschel P. 74
Fricke O. see Koss H. 82
Ganchev P. see Ganchev A. 71
Gardiner J.J. see Ward D. 76
Gerasimov V.T. see Chistyakov A.R. 79
Glori A.V. see Mendoza V.B. 76
Goebel N.B. see Lear D.H. van 73

Gordon J.C. see Dawson D.H. 76
Graaf N.R. de see Vries P.G. de 78
Grayson A.J. see Edwards P.N. 79
Gregory R.P. see Gilmore A.R. 74
Gvozdev V.K. see Grigor'ev V.P. 78
Hara H. see Wada K. 72
Hildebrand J.W. see Vries P.G. de 78
Hinton W.W. see Wittwer R.F. 78
Holt D.H. see Murphey W.K. 77
Huss J. see Bonnemanna 71
Huss J. see Muhle O. 72
Hwang J.W. see Hyun S.K. 74
Hyun J.O. see Hyun S.K. 74
Iliev S. see Iliev A. 75
Iliev S. see Zakhariev B. 75
Iliev S. see Zakhariev B. 80
Immel M.J. see Wittwer R.F. 78
Isebrands J.G. see Dawson D.H. 76
Isebrands J.G. see Nelson N.D. 81
Jeffers R.M. see Zavitkovski J. 81
Jeserigk P. see Bergmann J.H. 77
Johnson R.L. see Krinard R.M. 75
Johnson R.L. see Krinard R.M. 80
Jones B.E. see Endean F. 72
Jorgensen J.R. see Balmer W.E. 75
Kappich I. see Muhle O. 79
Keuffel W. see Brabander H.D. 76
Khalil M.T. see Hasan S.M. 80
Kimariyo P.E. see Adlard P.G. 74
King R.H. see Wittwer R.F. 78
Kiss R. see Halupa L. 75
Knapp E. see Dittmar O. 74
Kodama S. see Wada K. 72
Kohlstock N. see Dittmar O. 74
Konareva V.N. see Nekhaichuk O.G. 82
Korobov I.A. see Babenko D.K. 75
Kostov K.D. see Nikolov S. 79
Kravtsova P.S. see Shinkarenko I.B. 76
Kronka F.J.N. see Gurgel Filho O.A. 70
Kronka F.J.N. see Montagna R.G. 73
Kronka S.N. see Montagna R.G. 73
Kroth W. see Burschel P. 74
Laar A. Van see Tingle A.R. 71
Laidly P.R. see Barse R.G. 80
Laing F.M. see Lancaster K.F. 74
Landgraf L.K. see Wick H.L. 71
Lantz C.W. see Osterhaus C.A. 78
Lee D.K. see Hyun S.K. 74
Lee K.C. see Yang Y.C. 76
Leite N.B. see Simoes J.W. 74
Lemoine M. see Decourt N. 74
Lheureux C. see Andre P. 75
Liegel L.H. see Whitmore J.L. 80
Lin W.L. see Yang Y.C. 76
Lloyd F.T. see Harms W.R. 81
Lockow K.W. see Kohlstock N. 79
Lomov V.D. see Pinchuk A.M. 73
Lynch T.J. see Gallagher G.J. 80
Ma S.K. see Kim D.C. 74
Magnussen S. see Fromsdorf U. 80
Mainieri C. see Montagna R.G. 73
Malakhovets P.M. see Larin V.B. 72
Malinowski L. see Jezewski Z. 74
Mann W.F. Jr. see Enghardt H.G. 72
Mann W.F. Jr. see Feduccia D.P. 76
Manolova I. see Palashev I. 73
Manso D.M. see Hochmut R. 74
Marfurt T.A. see Sancho R. 72
Mascarenhas Sobrinho J. see Simoes J.W. 70
Mascarenhas Sobrinho J. see Mello H.A. 70
Mascarenhas Sobrinho J. see Mello H.A. 71
May J.T. see Steinbeck K. 72
McAlpine R.G. see Saucier J.R. 72
McAlpine R.G. see Steinbeck K. 72
McCormick W.C. see Lewis C.E. 72
Medina V.G. see Escobar R.R. 76
Meiden H.A. Van Der see Kolster H.W. 74-75
Meiden H.A. Van Der see Kolster K.W. 79
Mello H.A. see Coelho A.S.R. 70
Mello H.A. see Simoes J.W. 70
Mello H.A. see Couto H.T.Z. 73
Merrill W. see Bowersox T.W. 76
Merzlenko M.D. see Pisarenko A.I. 78
Merzlenko M.D. see Pisarenko A.I. 79
Metsamuuronen M. see Leikola M. 77
Mitev T. see Zakhariev B. 75
Morozova I.A. see Il'Inskii V.D. 75
Moskaleva V.E. see Nekhaichuk O.G. 79
Naumenko G.A. see Netrebenko V.G. 76
Nelson R.E. see Wick H.L. 71
Netto A.C. see Mello H.A. 72
Nicolielo N. see Simoes J.W. 74
Nienstaedt H. see Zavitkowski J. 81
Nikolov V. see Palashev I. 73
O'Brien D. see Gallagher G.J. 80
O'Sullivan P. see Gardiner J.J. 78
Opie J.E. see Incoll W.D. 79
Os'Kina N.V. see Utkin A.I. 80

Owens E.G. see Balmer W.E. 75
Palotas F. see Halupa L. 75
Parde J. see Oswald H. 76
Parde J. see Divoux A. 80
Peabody D.V. Jr. see Heilman P. 72
Peabody D.V. Jr. see Heilman P. 81
Pechmann H. Von see Burschel P. 74
Pepper W.D. see Belanger R.P. 78
Pereira A. see Pedroso L.M. 71
Petkov P. see B'Chvarov D. 72
Philip M.S. see Chamshama S.A.O. 80
Pollanschutz J. see Johann K. 74
Pollanschutz J. see Johann K. 80
Ponnuswamy P.K. see Husain A.M.M. 80
Popova N.M. see Popov V.K. 81
Prado D.J.A. see Garia S.J. 78
Prevosto M. see Proni G. 74
Prevosto M. see Proni G. 79
Prevosto M. see Proni G. 79
Proni G. see Prevosto M. 80
Purina L.T. see Nekhaichuk O.G. 82
Quezada J.L. see Escobar R.R. 76
Raalte G.D. Van see Day R.J. 70
Rahman S. see May J.T. 73
Rasanen P. see Leikola M. 77
Reukema D.L. see Curtis R.O. 74
Rohrig E. see Dohrenbusch A. 81
Romancier R.M. see Curtis R.O. 74
Rozhdestvenskii S.G. see Utkin A.I. 80
Russell K.W. see Hoyer G.E. 76
Sablin A.F. see Mitirev A.E. 76
Sanderson J.M. see Kilpatrick D.J. 81
Saucier J.R. see Lear D.H. 73
Savich Yu N. see Kuz'Michev V.V. 79
Savill P.S. see Kilpatrick D.J. 81
Sazon A.C. see Maun M.M. 72
Scaramuzzi G. see Ferrari G. 79
Schmidt P.B. see Volpato E. 73
Schneider G. see Neary D.G. 74
Schutz C.J. see Donald D.G.M. 77
Shestakova V.A. see Zhuravleva M.V. 81
Shibata N. see Wada K. 72
Shlyamar E.A. see Vakulyuk P.G. 80
Silen R.R. see Curtis R.O. 74
Simoes J.W. see Coelho A.S.R. 70
Simoes J.W. see Couto H.T.Z. 73
Simoes J.W. see Mello H.A. 70
Simoes J.W. see Mello H.A. 71
Simoes J.W. see Mello H.A. 72
Simoes J.W. see Mello H.A. 76
Simon E. see Andre P. 75
Siqueira A.C.M.F. see Nogueira J.C.B. 76
Sossaman E.C. see Gibson G.E. 77
Strand R.F. see Heilman P.E. 72
Strong T.F. see Zavitkovski J. 81
Taimisto E. see Leikola M. 77
Tamm C.O. see Hattemer H.H. 77
Tarasenko I.A. see Tarasenko V.P. 71
Thomasius H.H. see Thomasius H.O. 78
Tol G. Van see Low A.J. 74
Tompa K. see Tihanyi Z. 72
Tournon G. see Prevosto M. 80
Treimanis A.P. see Nekhaichuk O.G. 82
Tutygin G.S. see Larin V.B. 72
Unfried P. see Kenk G. 80
Vadachkoriya TS.T. see Pirtskhalaishvili S. KH. 75
Valdes E. see Hochmut R. 74
Veiga A. de A. see Gurgel Filho O.A. 70
Vencosky R. see Couto H.T.Z. 73
Vidacovic M. see Kristinic A. 71
Villela Filho A. see Simoes J.W. 74
Viswanathan M. see Husain A.M.M. 80
Volpato E. see Schmidt P.B. 72
Walters R.S. see Lancaster K.F. 74
Ward D., and J.J. Gardiner 76
Wasan Kaitpraneet see Bunvong Thaiutsa 76
White W.E. see Lewis C.E. 72
Whon J.S. see Kim S.I. 76
Williams R.D. see Clark P.M. 79
Wilson B.C. see Campbell R.K. 73
Wittwer R.F. see Wood B.W. 76
Wittwer R.F. see Wood B.W. 77
Wood G.B. see Siemon G.R. 76
Worst R.H. see May J.T. 73
Wright H.L. see Adlard P.G. 74
Yuodval'kis A.I. see Kairyukshtis L.A. 75
Zavitkovski J. see Strong T.F. 78
Zhuraleva M.V. see Savina A.V. 78
Zhurova P.T. see Shinkarenko I.B. 76

ANNOTATED BIBLIOGRAPHY

[listed alphabetically by senior author]

Abetz, P. 1971. (Spacing trials for Douglas fir.) Allg. Forstz. 26(21/22). (De).
From Forestry Abstracts: "Outlines a research programme for the whole of W. Germany, with parallel trials in the USA."

Abetz, P. 1973. (The forest and forest technology.) Forst-und Holzwirt. 28(15): 301-304. (De).
From Forestry Abstracts: "Includes a brief description of a general 'thinning aid' for Spruce in the form of curves based on the relation between stem number and dominant height, which, it is argued, is largely independent of site class in terms of yield. Curves of recommended stem numbers for given heights differ between sites with deep soils suitable for growing large timber and sites with shallow soils where trees are liable to windthrow. Another diagram presents recommended stem numbers before and after thinning for different thinning intervals based on height increments of 2, 3 or 4 m. The thinning aid is also applicable to mixed stands, e.g. of Spruce and Beech."

Abetz, P. 1974. (On the regulation of spacing in mixed stands and the selection of crop trees.) Allg. Forstz. 29(41): 871-873. (De).
From Forestry Abstracts: "For the purposes of thinning in mixed stands, the number of final crop trees per ha of each species can be calculated simply by multiplying (a) the number of final crop trees per ha for the same species when grown in pure stands by (b) the percentage of the area that each species should finally occupy in the desired mixture. Minimum distances between crop trees of the same or another species are tabulated for five species commonly grown in Germany. The intensity of thinning and the spatial arrangement of mixtures at planting time are discussed."

Abetz, P. 1976. (Responses of Norway spruce to enlargement of its growing space, and conclusions to be drawn for selective thinning.) Allg. Forst- und Jagdztg. 147(4): 72-75. (De, en, fr).
From Forestry Abstracts: "Discusses stem analyses of 48 trees, representing different crown classes, in a stand established at close spacing and thinned for the first time at 29 years of age by removing alternate rows (thereby reducing the stem number from ca. 4000 to ca. 2000/ha). In the subsequent 3 years, the treatment reduced height growth by ca. 50% vs. untreated controls, but stand b.a. increment was only slightly reduced. All trees increased in volume increment, but the radial response was much more marked in dominant trees, with relatively low height/diameter ratios, than in the more slender dominated trees, though the latter had been released more drastically. The more slender trees even increased their height/diameter ratios."

Acosta Romero, R. 1976. (Development of 6 species of pine at different spacings on thin red mountain soils at Vinales.) Baracoa 6(3/4): 3-12 (Es, fr, en).
From Forestry Abstracts: "Data are given on the growth (to 58 months) of 4 indigenous pines (Pinus caribaea var. caribaea, P. occidentalis, P. cubensis, and P. tropicalis) and 2 exotic pines (P. caribaea var. bahamensis and P. khasaya (P. kesiya) planted at 5 different spacings (3X1 to 3X3 m) at Vinales, Pinar del Rio province, Cuba. There were significant differences in ht. growth between the species, P. caribaea var. caribaea and P. caribaea var. bahamensis performing best. Although growth was

n.s.d. between the spacings, 3X2 and 3X2.5 m appeared to be technically and economically the best."

Adlard, P.G.; Wright, H.L.; Kimariyo, P.S. 1974. Stand and tree growth response to the low-thinning of even aged Pinus patula stands in Tahzania. I. Kiwira expt. No. 408 In: Tenth Commonwealth Forestry Conference. 15 pp. (En). Commonw. For. Inst., South Parks Road, Oxford, UK.
From Forestry Abstracts: "Stands planted in 1960 at 2360 m alt. at 2.74X2.12 m spacing were thinned as frequently as necessary to keep the stand b.a. within the ranges (a) 14-16, (b) 19-21, (c) 29-31 and (d) 44-46 m²/ha. Data are given for diam., stem form, vol., diam.-class frequency distribution and growing space up to 13.4 yr old."

Alder, D. 1979. A distance-independent tree model for exotic conifer plantations in East Africa. Forest Sci. 25(1): 59-71. (En). Dep. For., Oxford Univ., S. Parks Rd., Oxford, UK.
From Forestry Abstracts: "A simulation model of diam. increment for use under different thinning regimes is presented for Cupressus lusitanica, Pinus patula, and P. radiata growing in permanent sample plots in Kenya, Tanzania, Uganda, and Malawi. The diam. distribution is defined by a vector of diameters corresponding to fixed cumulative probability points. Increment of the diam. vector is a function of b.a. relative to max. b.a., diam. relative to dominant diam., and ht. as a site-dependent index of age. An algorithm for simulating thinning is based on the probability that a given stem will remain. Testing of the model against sample plot data showed that bias in total vol. prediction was negligible and s.d. of % residuals was 12-19%. Simulation of spacing experiments was accurate for initial stockings of 120-1400 stems/ha."

Aliev, Sh. 1975. (Pinus nigra var. caramanica in the foothills of Daghestan.) Leoni Khoz. 12: 55-57 (Ru).
From Forestry Abstracts: "Three types of plantations were established in 1937 in Daghestan on clay-loam soil prepared by ploughing, viz. (1) pure P. nigra var. caramanica, spaced at 1.5X1.5 m; (2) a mixture of 50% P. nigra var. caramanica and 50% Acer campestre, spaced at 0.8X1.5 m; and (3) pure Oak, spaced at 1.5X1.5 m. Mensurational details of the plantations at 35 years of age are presented. The results of growth assessments and financial evaluation indicate that the Pine is clearly superior to the Oak. Details are also given of recent trials on the production of P. nigra var. caramanica and P. sylvestris planting stock in the nursery in Daghestan. Recommendations are made on nursery practice and on planting. In the nursery, seed should be sown in fallowed soil in early spring, and shading is desirble in hot weather (>27°C). On completely cultivated plantation sites the Pine should be planted pure at 1X1.5 m. On felled areas and in lowgrade stands, the Pine should be planted in patches of 2-2.5 m² (500-600 patches/ha), at a density of 8-10 seedlings per patch."

Allen, H.L.; Duzan, H.W., Jr. 1981. What measure of stand density is best for growth predictions in loblolly pine plantations. In Proc. First Bienn. South. Silv. Res. Conf., Atlanta, Georgia, Nov. 6-7, 1980. USDA, Forest Serv., South. Forest Exp. Sta. Gen. Tech. Rep. SO-34: 175-178.
(En). Authors' abstract: "Stand density measures previously used for loblolly pine stands are reviewed and their ability to predict growth is compared. Because of its practical and theoretical advantages basal area

is recommended as the measure of density for use in growth and response models. A stocking guide based on maximum net volume growth and basal area is presented."

André, P. 1976. (First thinnings in conifer stands.) Bull. Soc. R. For. Bdg. 83(6): 312-331. (Fr). Lab. For. Univ. Louvain, Belgium.
From Forestry Abstracts: "The text of a lecture delivered on a 'study day' at Louvain, 29 June 1976. Preliminary results are given of thinning trials in Spruce (Picea abies) begun in 1969 when the stands were 21-30 years old. Thinnings are being carried out over 11 cycles of 3 years on a numerically controlled basis, the final crop trees being marked from the beginning. In each set of plots there is an unthinned control and five treatments, which will progressively reduce stocking from 2380 to 880 stems/ha in the lightest, and from 1780 to 320 stems/ha in the heaviest thinnings. The initial reduction in density from ca. 3600 to 2380...780 was made in the first thinning cycle. Mensurational data are given for one of the six experimental areas; an economic analysis indicates that the heaviest thinnings (much heavier than orthodox practice) are the most profitable. Heavy thinnings are also said to result in less wind damage. The effects on the form of the trees, and on the soil, etc., are discussed."

André, P. 1978. (Early reduction in density of conifer plantations.) Bull. Soc. R. For. Belg. 85(5): 195-201. (Fr, en, de, nl). Univ. Catholique de Louvain, Belgium.
From Forestry Abstracts: "To evaluate the effects of early thinning, 3 Norway spruce plots, planted in central Belgium in 1952 at 1X1 m spacing, were thinned systematically in 1962, when the canopy had closed, by removal of alternate rows, or alternate rows and also alternate trees in the remaining rows; controls were left unthinned. Normal thinning was carried out 13 yr later, when the proportion of trees over 50 cm diam. was 35.1, 65.8 and 73.3% and basal areas were 31.8, 29.0 and 28.7 m^2/ha respectively. Stems of early-thinned trees showed very uniform growth and good potential; the thinning at 23 yr yielded trees of a more economic size, and future quality was unimpaired."

André, P.; Antoine, R. 1972. (Early growth of Pendunculate oak (Quercus robur) on Quaternary alluvium (in lowland Belgium).) Rev. For. Fr. 24(1): 39-46. (Fr).
From Forestry Abstracts: "Describes, and illustrates with tables and graphs, the growth and silvicultural treatment of a stand planted at Eegenhoven in 1942 at 2X2-m spacing on the type of site normally allocated to poplar growing. The data show that Q. robur of high quality and high yield (comparable with the French quality-class I) can be grown on such sites."

André, P.; Lheureux, C.; Simon, E. 1975. (Planting density and early growth of Pinus nigra var. maritima.) Bull. Soc. R. For. Belg. 82(2): 107-116. (Fr, nl, de, en).
From Forestry Abstracts: "Describes a spacing experiment in a plantation of P. nigra var. maritima established on a sandy alluvial soil in Meerdaal forest, Belgium, in 1959. The spacings compared were 1.25X1.25, 1.50X1.50, 1.75X1.75, and 2.0X1.0 m. Measurements after 13 years showed that maximum and mean heights were not affected, but certain individual characteristics, e.g. mean d.b.h., b.a. and volume, were significantly

correlated with initial stand density, the highest values being attained at the widest spacing. Total volume per ha, however, fell significantly with increasing width of spacing. Within the limits of the experiment, the rate of diameter growth showed a marked decrease with time at all the spacings compared. After allowing for the need for thinning throughout the plantation, form factor was apparently not significantly affected by initial spacing. The trees with the largest branches were those of greatest d.b.h. From a silvicultural point of view the results justify the practice of using wide spacings, which is recommended on economic grounds."

Angel Menéndez, M. 1971. (The growth of Quercus ruber in the '25 de Mayo' district of Buenos Aires province.) Rev. For. Argent. 15(3): 69-72. (Es).
From Forestry Abstracts: "Presents growth data from experimental plots of Q. ruber established in 1957, using 2-year-old planting stock, and a spacing of 3X3 m. After 13 years (in 1970) m.a.i. is estimated at 14.1 m³/ha (volume) and 1.4 cm/tree (diameter). The growth rate and the quality of the virgin cork are considered promising."

Anon. 1971a. (The initial growth of Pinus elliottii, P. taeda, and P. patula at different spacings.) In: Actas del 'primer Congreso Forestal Argentino - del Gal 11 octubre de 1969. Sesion A-III. Servicio Nacional Forestal, Buenos Aires. (Es).
From Forestry Abstracts: "Gives some data from plantations...from age 3 to 7 years..."

Anon. 1971b. (Peroba Amarela (Paratecoma peroba) in a highly successful experiment in Linhares, Espirito Santo (Brazil.) Brasil Florestal 2(8): 10-12. (Pt).
From Forestry Abstracts: "Plantations of P. peroba, covering ca. 20 ha, established by the Companhia Vale do Rio Doce in 1964 and 1965 at initial spacings of 4X3 and 5X3 m, attained a mean height of 10 m at age 6-7 years, some individuals being >11 m high. Brief notes are given on the topography and climate of the area, with tabulated data on the physical and chemical properties of the soils."

Anon. 1972a. (The influence of mulching with black polythene sheeting on the survival and growth of a plantation of Pinus nigra var. calabrica.) Rev. For. Fr. 24(1): 47-50. (Fr).
From Forestry Abstracts: "A distinct improvement in initial growth and survival was obtained in a plantation of P. nigra var. calabrica (spacing 2X2 m) in the state forest of Orleans by mulching experimentally with 1X1 m black polythene sheets 60, 80 or 100μm thick; sheets 40μm thick were not strong enough. The trees were planted on a clear-felled site on bare soil, and a polythene sheet with a hole in the middle was placed over each plant as soon as it was planted. Although the treatment virtually eliminated the need for weeding in the first 3-4 years, the extra cost was still too great to justify mulching in this manner in normal practice unless the technique could be improved."

Anon. 1972b. Plantation silviculture: sub-tropical coastal region (Optimum initial spacing of Pinus elliottii). In Annual Rep. of the Dep. For., Queensland 1971/72: 14-15. (En).

From Forestry Abstracts: "Evaluates a trial established in 1940. Tabulated data show that money values of the standing crop at 20 years old were greatest (with current prices) at 9X9 ft spacing although the total merchantable volume increased with increasing stand density (up to 7X7-ft spacing)."

Arnold, L.E. 1978. Gross yields of rough wood products from a 25-year-old loblolly and shortleaf pine spacing study. Dep. For., Univ. of Illinois, USA, For. Res. Rep. No. 78-7. 4 pp. (En).
From Forestry Abstracts: "Ht., d.b.h., survival, and calculated vol. yields are discussed for trees in a plantation in S. Illinois which had been established in 1949 at spacings of (a) 4X4, (b) 6X6, (c) 8X8, or (d) 10X10 m. Greatest saw timber vol. (to 8-inch top) was for P. taeda at (d) (4200 bd ft/acre). Greatest peeled vol. in P. taeda was at (c) (4889 ft^3), in P. echinata at (b) (3803 ft^3)."

Assmann, E. 1975. (On the methodology of forest trials (thinning and spacing.) Forstwiss. Centralbl. 94(6): 255-264. (De, en).
From Forestry Abstracts: Criticizes the Scottish Norway Spruce thinning trial at Bowmont (cf. FA 26, 2187) (chiefly as regards the inadequate size of the plots, edge effects and the difficulties inherent in measuring merchantable volume on standing trees) and the Bavarian spacing trial at Wessling (cf. FA 18, 4016) (Chiefly as regards site differences and the masking influence of uniform thinning on the effects of initial spacing), and briefly describes small-scale morphometric studies on 'biogroups' (consisting of a dominant central tree and its 6-8 nearest neighbours) in which comparisons were made of the development of volume and dry-weight increment of the central trees at ca. 60 years old in plots with square spacings of 1.1, 1.9 and 4 m. The 'biogroup' studies showed that stem increment increased with reduced competition (measured by an index expressing distance from and crown size of neighbours) and with increased crown projection, but that stem volume and dry-matter increment of the stem per m^2 of grown projection decreased. The latter finding is attributed in part to a considerable increase in the weight of dead branches and also, especially at the 4-m spacing, to relatively poor photosynthetic performance. Recent recommendations for initial spacings are criticized, and figures of 4500 or at least 3500 plants/ha are recommended for similar good sites.

Atamanyuk, Yu. A. 1971. (Mensurational structure of young oak plantations established (by sowing or planting) in groups.) Lesn. Zh. 14(5): 23-25. (Ru).
From Forestry Abstracts: "An analysis of the variation in height and diameter of Oak aged 16-19 years, established as 'biogroups' of various arrangements, containing various numbers of trees, in the Ukraine."

Aussenac, G. 1979. (Litter production in four young Douglas fir stands in eastern France.) Rev. For. Fr. 31(1): 15-19. (Fr).
From Forestry Abstracts: "(See FA 31, 3801) Fallen organic matter, mostly needles, was collected between May 1972 and Sept. 1973 in 20 rain guages in each of 4 plots of Douglas fir in the state forest of Amance. All were 15 yr old, part of an experiment on plantation density, and had 1118, 1484, 2310 and 4265 stems/ha respectively. Annual litterfall was estimated at 3.4-3.7 t/ha and was not related to stand density (all plots

having closed canopy). Max. fall occurred in July-Aug. with a secondary peak in Nov. and min. in Dec.-March."

Babenko, D.K.; Korobov, I.A. 1975. (Effect of intensive tending fellings on the growth of Scots pine.) Lesn. Khoz. 8: 49-51. (Ru).
From Forestry Abstracts: "Describes a thinning trial in a stand planted in 1955 at a spacing of 3X0.5-0.7 m in the sandy region of the lower Dnieper. The first thinning was done in 1960, leaving 3000 or 2500 trees/ha; unthinned control plots had 5600 trees/ha. Mensurational data are given for the plots at 18 years of age, including the % distribution by natural diameter classes, aerial and root biomass, and canopy density. The results are discussed; they show that in these conditions the first thinning should reduce the stand to 2500 trees/ha. Thinning of this intensity results in increased diameter increment for 12 years. The second thinning becomes due when the plantation is 18 years old."

Balmer, W.E.; Owens, E.G.; Jorgensen, J.R. 1975. Effects of various spacings on loblolly pine growth 15 years after planting. USDA Forest Serv., SE For. Exp. Sta., Res. Note SE-211, 7 pp. (En).
From Forestry Abstracts: Describes a spacing study established in 1956-1957 at the Calhoun Experimental Forest, S. Carolina, to assess the merits of four spacings of Pinus taeda (6X6 ft, 8X8 ft, 10X10 ft, and 12X12 ft). Survival was poorest, and trees generally showed the lowest d.b.h. and height growth, at the 6X6-ft spacing. The greatest volume of saleable timber was produced at the 8X8-ft spacing, and most trees thus grown were suitable for pulpwood production. Trees at wider spacings were generally taller and larger in diameter than closely spaced trees, and the volume of sawtimber produced was greater at the wider spacings. Few trees at the 10X10-ft spacing, however, were saleable as sawtimber at age 15, and potential for early pulpwood production was lost with wider spacings. Recommendations are made on spacings to suit the requirements of landowners and the soil conditions in S. Carolina.

Barangan, F. 1978. Spacing of Benquet pine (Pinus kesiya Royle ex Gordon) in Laparan, Malaybalay, Bukidnon. Sylvatrop 3(1): 45-50. (En). For. Res. Inst., DNR, Malaybalay, Bukidnon 8201, Philippines.
From Forestry Abstracts: "Pinus kesiya seedlings were planted in 1970 at spacings of (a) 1X1, (b) 1X2, (c) 2X2, (d) 2X4 and (e) 4X4 m and growth measurements were recorded annually for 7 yr. Ht. growth was n.s.d. between treatments, mean diam. increment and % survival were best in (e) and b.a. was best in (a)."

Barannik, A.B. 1978. (Silvicultural affectiveness of creating spruce plantations with large seedlings in the taiga zone.) Leon. Khoz. 4: 47-49. (Ru).
From Forestry Abstracts: "Comparisons were made of the performance at 12 yr of plantations established with seedlings of Picea abies 2 and 4 yr old. The planting was done in spring 1958 at a spacing of 2X0.8 m, and data are tabulated on survival in the first, second, third and twelfth years, and on mean ht. after 10 yr in the field. Survival and growth were significantly greater with the 4-yr-old seedlings. Data are also tabulated showing the mean ht. at 10 yr of plantations established with seedlings 5.5, 7.5, 9.5...23.5 cm high at time of planting. Height increased with increasing original ht. of planting stock. It is concluded that the use

of large healthy seedlings approx. 23 cm high offers substantial advantages, and that the resultant higher growth rates achieved should be taken into account in the compilation of yield tables."

Barrett, J.W. 1970. Ponderosa pine saplings respond to control of spacing and understorey vegetation. USDA, Forest Serv., Pacific Northwest For. Range Exp. Sta., Res. Pap. PNW-106. 16 pp.
From Forestry Abstracts: "Results after a further four years confirm those already reported (see FA 27 No. 5948), viz. that response in diameter and height growth was greatest with the lowest densities and with removal of understorey vegetation."

Barrett, J.W. 1972. Large-crowned ponderosa pine respond well to thinning. USDA Forest Serv., Pacific Northwest For. Range Exp. Sta., Res. Note PNW-179. 12 pp.
From Forestry Abstracts: "A 33-year-old Pinus ponderosa plantation, established at 6X6-ft spacing in E. Oregon, was thinned in 1959 to spacings of 8.8X8.8 to 17.6X17.6 ft. After 11 years, stands with the lowest density (140 trees/acre) had produced nearly the same volume increment as those with the highest density (560 trees/acre). Height increment did not differ significantly between treatments."

Barse, R.G.; Laidly, P.R. 1980. Wood specific gravity of plantation red pine (Pinus resinosa in Wisconsin) little affected by spacing. USDA, For. Serv., North Ont. For. Exp. Sta., Res. Note NC-251. 2 pp.
Authors' Abstract: "Shows stocking density has little effect of wood specific gravity of red pine."

Bartoli, M. 1971. (First results (at 11 and 15 years) of a planting density experiment on Douglas fir.) Rev. For. Fr. 23(6): 605-608. (Fr).
From Forestry Abstracts: "Tabulates and discusses data from both the 1966 and 1971 measurements in the Pseudotsuga menziesii spacing experiment near Nancy previously described. In general, the 1971 measurements confirmed the observations made earlier. By its dominant height, which at 15 years was unaffected by spacing (although mean height was slightly affected), the plantation can be assigned to P. menziesii quality class II, the class to which other stands of the species in Lorraine have been found to belong."

Bartoli, M.; Décourt, N. 1971. (Spacing of (softwood) plantations. Review and first results of an experiment with Douglas fir.) Ann. Sci. For. 28(1): 59-81. (Fr, en, de).
From Forestry Abstracts: "Analyses data from some spacing experiments in Europe and N. America with Pinus resinosa, P. elliottii, P. sylvestris, P. radiata, Picea abies and Pseudotsuga menziesii, including information on form factors, number and size of branches, mortality, crown closure, litter formation etc. as well as on the usual parameters e.g. height, diameter, b.a. volume etc., and gives the results of the first measurements made in a latin-square experiment near Nancy in which P. menziesii was planted at spacings of 1.50X1.50, 2.0X2.0, 2.50X2.50 and 3.0X3.0 m in 1955. When measurements were made in 1966 there was no evidence that spacing affected height growth or mortality among the trees, but it certainly affected diameter, b.a., volume, stem form and mortality of low branches."

B''Chvarov, D. 1980. (The initial density of Pinus nigra plantations, and its affect on certain mensurational indices.) Gorskostop. Nauka. 17(6: 3-22. (Bg).
From Forestry Abstracts: "Plantations were established in Bulgaria in 1972 at 12 different densities (1100-40 000 plants/ha). Data to 1977 are presented on the growth of the trees, and on the development of their root systems. Comparative investigations were also made on plots of varying density in a 25-yr-old plantation. The effect of initial density on ht. and diam. increment, crown width, and branch length and diam. was determined. The findings are discussed in relation to stem quality and thinning."

B''Chvarov, D.; Petkov, P. 1972. (Initial density in Pinus nigra plantations in the E. Rhodope mountains.) Gorskostop. Nauka. 9(3): 25-34. (Bg, ru, fr).
From Forestry Abstracts: "Gives data on tree classes and dimensions in eight plantations in Bulgaria aged 17-21 years and having 1100 to 5880 trees/ha (initial densities from 1600 to 10 000 trees/ha). Mean d.b.h. was related to density (in the range 1100-5800 trees/ha) as follows: y = (12 600/x) + 5.74. The number of low-quality stems decreased with increasing density."

Beck, O.A. 1981. (Silvicultural treatment of the bird cherry.) Allg. Forstz. 9/10: 212-213. (De).
From Forestry Abstracts: "A brief review of the silvicultural handling of Prunus avium and its value as a timber species and for landscape uses. The species is light-demanding, and prefers rich, deep soils, especially on moist, S.-facing slopes. Growth is rapid up to age 25 yr, with ht. growth ceasing by age 60-70 yr. D.b.h. can reach 50 cm by age 60 yr; ht. can reach 40 m on optimal sites. Silvicultural recommendations include: establishment individually, or in clusters with spacing of 1.5-2X2-2.5 m; pruning at d.b.h.: 12-15 cm; subsequent tending to encourage free crown development; and protection from game damage. A strong market for P. avium timber exists; branch-free veneer logs can bring 1500-2000 DM/m³."

Reen, A. 1972. (Line planting in steep terrain.) Tidsskn. Skogbruk. 8(4): 471-478. (No, en).
From Forestry Abstracts: "Describes Norwegian work studies on the line planting of 23 900 four-year-old Picea abies with a mattock on slopes with gradients varying between 40 and 90%. Planting spacing was 4X1.5 m. Results showed that the time taken in moving the lines accounted for 30-50% of the working time, and that the planting rate declined from ca. 550 plants/man-day on a gradient of <10% to ca. 300 plants/man-day at >50%."

Belanger, R.P., Pepper, W.D. 1978. Seedling density influences the early growth of planted sycamore. Forest Sc. 24(4): 493-496.
From Forestry Abstracts: "American sycamore (Platanus occidentalis) was grown at densities of 200-27 000 trees/ha, in a 2.5-ha bottomland (moderate to poor) site in Georgia. At 6-yr-old, total ht. was greatest at about 1000-5000 trees/ha, and stem diam. was greatest at densities up to 5300 trees/ha. The proportion of branchwood per tree increased as stocking decreased, and the greatest green wt. yield (60 000 kg/ha) occurred at the highest density. It is concluded that moderate competition among trees is necessary for max. ht. increment and for a high stemwood/branchwood ratio; an initial stocking of 1500-3000 trees/ha is suggested."

Bella, I.E. 1974. Growth response of young jack pine to mechanical strip-thinning, Manitoba. Can. For. Serv., North. Forest Res. Cent., Inf. Rep. NOR-X-102. 11 pp. (En, fr).
From Forestry Abstracts: "Evaluates, in terms of growth 10 years after treatment, the effectiveness of two intensities of mechanical thinning in 9-year-old Pinus banksiana stand on (a) fresh (moderately moist) sites, and (b) moist sites, on nutritionally poor sandy soils in SE Manitoba. In the stands on (a), where the average initial density was 12 000 stems/acre, d.b.h. increment of the larger trees adjoining the cut strips was increased by 40-50%, but that of the remaining trees was scarcely affected. There was little difference in the response to one-way thinning (7-ft-wide strips cleared with a Fleco drum chopper, leaving 10-ft- wide belts of trees) vs. two-way thinning (the one-way thinning followed by a similar treatment at right-angles, so as to leave groups of trees in blocks of 10X10 ft). The same treatments in denser stands on (ba), where the average initial density was 26 000 stems/acre, produced no significant results. It is concluded that, unless marked improvements in growth occur in later years, this type of strip thinning on its own must be considered unjustified, though it may be useful if followed by selective thinning along the edges of the thinned strips. (Cf. FA 32, 6009)."

Bella, I.E.; Franceschi, J.P. De. 1974. Early results of spacing studies of three indigenous conifers in Manitoba. Can. For. Serv., North. Forest Res. Cent., Inf. Rep. NOR-X-113. 10 pp. (En, fr).
From Forestry Abstracts: "Pinus banksiana, P. resinosa and Picea glauca were planted at 4-, 6-, 8- and 10-ft spacings in an IIX11-ft matrix with four replications on fresh (moderately moist) sites on nutritionally poor sandy soils in Sandilands Forest Reserve, Manitoba. The effects of spacings on various growth parameters were assessed eleven growing seasons after planting. Spacing had no significant effect on the height growth of any of the species. The diameter growth of P. banksiana was best at the two intermediate spacings, but that of P. resinosa was not affected by spacing. The crown width of both Pines increased with width of spacing, but the stem form of P. banksiana deteriorated. P. banksiana grew >30% faster in diameter and height than P. resinosa and might prove superior for pulpwood production. P. resinosa retained a good stem form even at 10-ft spacing and seems more suitable than P. banksiana for sawlog production without thinning. The two Pines grew roughly twice as fast in height as Picea glauca."

Bella, I.E.; Franceschi, J.P. De. 1980. Spacing effects 15 years after planting three conifers in Manitoba. Can. For Serv., North. Forest Res. Cent., Inf. Rep. NOR-X-223. ii+10 pp. (En, fr).
From Forestry Abstracts: "Pinus banksiana, P. resinosa and Picea glauca were planted at 1.2, 1.8, 2.4 and 3.0 m square spacings in IIX11-tree matrices at 2 locations in Manitoba. B.a. increment from 1973-1978 (15 yr after planting) was 165% greater at 3.0 than at 1.2 m for P. banksiana, and 106% greater for P. resinosa. Ht. growth was reduced with increasing spacing in P. banksiana but was unaffected in P. resinosa. Average ht. of P. glauca was less than half that of the pines; the trees were too small to show spacing effects. P. banksiana developed poor form and heavy branches at wide spacings; P. resinosa showed little adverse effect. Mortality was low in all stands. Stand productivity (b.a., vol. and biomass) was greatest at 1.2 m spacing, but continued faster growth at wider spacings

would reduce or eliminate this advantage by rotation age. Recommendations are given for species selection and spacing in Manitoba."

Belyi, G.D. 1975. (Stand density and its regulation in the control of Fomes annosus.) Lesovod. Agrolesomelior. Resp. Mezhred. Temat. Nauch. Sb. 40: 28-35. (Ru).
From Forestry Abstracts: "Reviews the literature and reports investigations made in the Ukraine, confirming that the resistance of Pinus sylvestris to infection by F. annosus is higher in stands of low density. It is recommended that plantations should be established at not more than 2500-2000 plants/ha, and that existing stands up to 10 years old should be thinned severely to 3000-4000 trees/ha."

Belyi, G.D.; Alexseev, I.A. 1980. (Growth and resistance of Scots pine plantations to Heterobasidion annosum.) Lesn. Khoz. 2: 55-57. (Ru).
From Forestry Abstracts: "An account is given of the performance of plantations established in Ukraine in 1970 on areas clear-felled because of infection by H. annosum. Various site-preparation treatments were compared, viz. stumps removed or stumps left; deep ploughing plus application of complete fertilizer plus sowing of lupin; conventional ploughing plus fertilizer plus lupin; deep ploughing plus lupin, and conventional ploughing plus lupin. The plant spacings were 2X1 and 2X0.7 m. Data are tabulated on the ht. of the trees each year up to 1978, and on the incidence of infection in the plantations at 8 yr. Infection by H. annosum was worst on the sites where the old stumps had not been removed, but even complete stump removal did not eliminate the souce of infection entirely. The application of fertilizers was not very effective in improving growth or resistance of the pine. Perennial lupin should be introduced by sowing when the plantations are 3 yr old, not by sowing before planting."

Bennett, F.A. 1971. Modern thinning practice - technical and economic effects. Pages 33-45 in Southern pine management - today and tomorrow. Baton Rouge, USA, Louisiana State University. (En).
From Forestry Abstracts: "Argues that in Slash Pine plantations, and also in plantations of other Southern Pines, thinning does not greatly affect the volume yield either of cordwood or sawtimber, provided that the initial spacing is appropriate for the desired product. The economic desirability of thinning for early recovery of establishment costs or for reduction of the capital invested in growing stock is also questioned, and the adverse effect of wide initial spacing on quality is not considered to be very important economically. Tabulated data on the effect of initial spacing and subsequent thinnings on yields and returns at Olustee, Florida, are presented to support the argument."

Ben Salem, B. 1975. (Planting in widely spaced groups: a promising technique for enriching the maquis.) Tunisia, Inst. Nat. Rech. For., Bull. d'Info. 19: 13-16. (Fr).
From Forestry Abstracts: "Describes the principles of this method of regeneration, which involves the establishment of small groups of closely planted trees (5-25 seedlings at a spacing of 1X1 m within square plots of 3X3 or 4X4 m) distributed throughout the maquis at any density desired and the subsequent selection and retention of the best tree in each group, and

briefly reports promising results of a trial of the method with Eucalyptus astringens in northern Tunisia."

Berben, J.C. 1975. (Trials on improvement of the yield from Pinus sylvestris and P. nigra var. maritima in Campine.) Bull. Soc. R. For. Belg. 82(3): 129-156. (Fr, nl, en, de).
From Forestry Abstracts: "Describes two fertilizer experiments, on Pinus sylvestris and P. nigra var. maritima respectively, made primarily to determine the effect of fertilizer applications and spacing on the growth of young plantations established, with 2-year-old planting stock, on a typical Campine podzol. The first experiment concerned the response of P. sylvestris, planted at three spacings (1X1, 1X2 and 2X2 m) on cultivated strips 50 cm wide over deep-ploughed furrows along the axis of the rows, to the application of a complete (NPKCa) fertilizer. The second experiment, on P. nigra var. maritima, comprised a similar fertilizer/spacing trial with the addition of a comparison between strip cultivation and complete ploughing. Height growth was measured annually from 1959 to 1971 and girth was measured in 1971. The results showed that: the beneficial effect of the fertilizer was still apparent after 14 years; in P. sylvestris, faster height growth lasted for 10 years, while in P. nigra var. maritima it was still evident after 14 years; the greatest increase in annual height increment occurred after 6 years in P. sylvestris and 8 years in P. nigra var. maritima, the fertilizer resulted in an increase in the girth of P. nigra var. maritima but not of P. sylvestris in the experiment on P. nigra var. maritima there was no difference between the soil treatments; the widest spacing led to the greatest girth increment; and spacing had a marked effect on annual height increment in P. sylvestris only."

Berben, J.C. 1975. (Growth of Corsican pine after grading of 1+1 planting stock.) Bull. Soc. R. For. Belg. 82(6): 297-308. (Fr, nl, de, en).
From Forestry Abstracts: "In 1964, seedlings of Pinus nigra var. maritima were graded by size (large, medium and small), and planted at spacings of 1X1, 1.25X1.25 and 1.50X1.50 m on dry sandy soils in the Campine. Mortality was estimated at the end of the first summer, and the effects of grading and spacing were studied after 10 years. The large and medium-sized plants were respectively 20-30% and 10-20% superior to the small plants in relative height growth. After 5 years, the effect of grading was still noticeable on good but not on poor sites; after 10 years, the effect of discarding 1/3 of the seedlings (the smaller ones) was a 5 to 7% increase in height. It is concluded that grading P. nigra var. maritima stock both improves the average growth of the stand and reduces the need for beating up. After 10 years no significant effect of spacing on tree growth was yet apparent."

Berben, J.C. 1978. (Spacing and growth of Corsican pine and Japanese larch.) Bull. Soc. R. For. Belg. 85(2): 61-70. (Fr, nl, en, de).
From Forestry Abstracts: "In 1959 Corsican pine and Japanese larch (Larix leptolepis) were planted separately or in 50/50 mixture at spacings of 1.5X1.5, 1.5X3, 3X3 or 3X6 m on a podzol of the Belgian Campine. After 16 yr Corsican pine but not Japanese larch had the potential to produce saw-timber at 50 yr. Spacing of 1.5X3 m gave best returns and easiest field operations; wider spacing reduced yield and quality of timber. At 1.5X1.5 m income would be available from thinnings after 30 yr. Mixed planting reduced growth of both species compared to pure stands."

Berenhauser, H. 1971. (Spacing in plantations of Pinus elliottii and P. taeda.) Floresta 3(2): 21-27. (Pt, en).
From Forestry Abstracts: "Makes recommendations (based largely on experience in the USA) for the initial spacing and tending of Brazilian plantations of P. elliottii and P. taeda for pulpwood and sawtimber production. (Cf. FA 31 No. 6022.)"

Bergel, D. 1973. (Edge effects in sample plots in young stands.) Forstanchi. 44(11): 234-237. (De, en).
From Forestry Abstracts: "An analysis of edge effects in 13-year-old provenance trials of Larix decidua and L. leptolepis planted respectively at spacings of 2X2 m and 1.2X1.2 m showed that the outermost rows had considerably larger diameters, which largely reflected the increase in available growing space. Diameters were greater for L. leptolepis than for L. decidua, and greater along adjoining roads than along narrower dividing strips originally planted with 1 row of Spruce that had since mostly failed. A small superiority of diameters in S. and W. edge rows over N. and S. edge rows reached significance level only for the N. row in L. leptolepis. In the second rows, the only significant diameter differences were in rows of L. leptolepis bordering on roads."

Bergmann, J.H.; Jeserigk, P. 1977. (The effects of wider spacings of pine on tending measures.) Beitov. Forstwirt. 11(1): 12-17. (De, ru, en).
From Forestry Abstracts: "Composition and % cover of ground vegetation is recorded for 3 pine (Pinus sylvestris) stands, with and without herbicide treatment. The effect of recently-advocated wide plant spacings on weed-control requirements are discussed."

Berry, A.B. 1974. Crown thinning a 30-year-old white spruce plantation at Petawawa - 10-year results. Can. For. Serv., Petawawa Forest Exp. Sta., Inf. Rep. PS-X-49. 2+16 pp.
From Forestry Abstracts: "A thinning experiment to examine the relation of stand growth to density of residual growing stock was established in 1962 at Petawawa, Ontario, in a 30-year-old Picea glauca stand planted at 6X6-ft spacing on a sandy old-field site. Two sample plots per treatment were treated by crown thinning to b.a. values of 80, 110 and 140 ft^2/acre, and two control plots were left unthinned. The plots were remeasured after 10 years. Diameter increment of individual trees was highest in the plots thinned to 80 ft^2 b.a. and decreased with increasing residual stand density; at a given density, the larger the tree, the greater the diameter increment. Differences in b.a. and volume increment per acre between treatments were not statistically significant, but were too large to be ignored. B.a. increment was highest at 110 ft^2 b.a./acre. Periodic annual volume increment (1962-1972) increased with increasing stand density from 137 ft^3 at 80 ft^2 to 207 ft^3 for the unthinned controls, but <90% of the maximum increment was obtained at densities of >110 ft^2/acre. To ensure near-optimum volume growth per tree combined with <90% of maximum stand volume increment per acre, thinning should not reduce residual b.a. to <110 ft^2/acre. (Cf. FA 32, 717)."

Bhatia, K.S. 1980. The growth of Eucalyptus hybrid (syn. E. tereticornis) on eroded alluvial soils of Uttar Pradesh in relation to spacing, irrigation and manuring. Indian For. 106(10): 738-743. (En, hindi).

From Forestry Abstracts: "A report of trials at Kanpur (rainfall 817 mm/yr), on slightly alkaline deep eroded alluvial loams with 0.047% total N. Seedlings 6 months old were planted at 1.5X1.5, 2.5X2.5 and 3X3 m spacings with irrigation of zero, 4 or 8 waterings (? annually), with or without 1 ft³ of farmyard manure added to the planting pit. Best growth at 4 yr old was for 3X3 m spacing with 8 waterings and manure."

Bondarenko, N. Ya.; Eterevskaya, L.V. 1972. (The spacing of Scots pine in plantations.) Lesn. Khoz. 11: 33-34. (Ru).
From Forestry Abstracts: "Describes an investigation of the growth of plantations 8 years old, with initial tree spacings of 1.5X0.7, 2.5X0.6, and 3.0X0.5 m, on sandy soils in the Volgograd region (SE Russia). Particular attention is paid to the number, length and distribution of the roots, and the ratio of roots to needles. Results indicate that, judged by these criteria, 2.5X0.6 m is the best spacing."

Bondarenko, V.D. 1976. (Regulation of the water provision of vak plantations on semi-arid Quercus frainetto sites.) Les. Kh.-vo, les., bum. i derevoobrab. prom.-st'. Resp. mezhved. nauchi-tekhn. sb. 7: 12-15. (Ru).
From Forestry Abstracts: "A qualitative estimate is given to the water supply of Oak (Q. robur) plantations of different densities (in Soviet Moldavia) on the basis of a study of the chemical potential of soil moisture. Where water resources are limited, consumption can be regulated by determining the optimum density of planting."

Bonduelle, P. 1978. (Silvicultural and pulping results of a first coppicing of poplar.) Pages 296-338 in Ann. Rech. Sylvicoles 1977. Association Forêt-Cellulose. Paris, France. (Fr, en, de).
From Forestry Abstracts: "Cuttings of Populus 'Rochester' and P. trichocarpa 'Koreana 39' were planted at Drambon, Côte d'Or, at 3 000, 6 000 and 9 000/ha in spring 1970, cut back 2 yr later and harvested in winter 1976-7. Data are given on production. Pulping properties are described for harvests of whole trees at 2 yr and for the 5-yr-old coppice. High bark and juvenile fibre content makes short-rotation coppice less good than adult poplar; it would be better with trees 6 to 8 yr old. Bark can be reduced to less than 10% (with less than 5% loss of wood) by compression barking after steaming. The pulp characteristics were similar for both clones and all 3 densities. The optimum planting density is thought to be between 2 000 and 6 000/ha according to the clones used. Manual harvesting of the coppice and suggestions on how it might be mechanized are separately reported in an appendix by H. Petit, separately noticed in FA and FPA."

Bonnemann, A.; Huss, J.; Warth, H. 1971. (Initial spacing of European larch.) Forstarchiv 42(6): 116-122. (De, en).
From Forestry Abstracts: "Discusses a small-scale trial in N. Hesse established in 1952 at spacings of (a) 1X1, (b) 2X2 and (c) 3X3 m, and assessed at ages 17 and 22 years. Though b.a., volume and stem form at 22 years were best with (a), and height only slightly inferior, this spacing is not considered satisfactory because diameters were small. With (c), stem form and branching habit were unsatisfactory. Spacings of 1.5X1.5 to 2X2 m are thought best. In (a), natural Beech regeneration was suppressed; in (b)

and (c) it survived and sometimes developed satisfactorily. The trial will be continued after pruning and heavy thinning."

Borota, J. 1971. The result of the oldest thinning experiment in Pinus patula. Silv. Res. Note Tanz. No. 18, 7 pp.
From Forestry Abstracts: "Two plots at Kigogo, Tanzania, carrying (a) 2618, and (b) 2546 trees per ha, were thinned 5 times from age 7 to 20.5 years, so that of the original numbers of trees only 5% remained on (a), and 12% on (b). Measurements up to age 25 years show that total volume production (including thinnings) was about 17% higher in (b) than in (a)."

Borough, C.J. 1978. Growth of radiata pine at low densities. Pages 201-204 in Integrating agriculture and forestry. Proc. of a workshop held at Bunbury, Western Australia. (Sept./77) Perth, Australia; CSIRO Div. For. Res.
From Forestry Abstracts: "Data from spacing trials in the Australian Capital Territory were used to predict growth of radiata pine under various management regimes and for 3 site indices. It is stressed that since data were taken from management strategies unlike those used for the predictions, the extrapolated results should be viewed with caution."

Bosch, R. 1981. (Establishment of poplars in Forest Ranger District Rastatt.) Allg. Forstz. 15: 355-358. (De).
From Forestry Abstracts: "Ht. and d.b.h. performance is discussed for poplar clones/hybrids established (1967-75) in 6X6 m square plantings in water meadows regularly flooded by the Rhine in Baden-Wurtemberg. Forms evaluated include: Populus nigra material, including P. 'Regenerata Deutschland', P. 'Neupotz', and P. 'Bietigheim'; P. trichocarpa material (and hybrids), including P. 'Androscoggin', P. 'Fritzi Pauley', P. 'Oxford', P. 'Rochester', P. 'Muhle Larsen', and P. trichocarpa X P. koreana; and P. 'Löns'. The P. trichocarpa forms exhibited particularly good growth (including rapid early growth) on sites with pseudogley soils and with acid/base poor stagnant water, as well as on drier sites; P. nigra material performed better on sites with open, aerated soils. The tendency of P. trichocarpa to proliferate new regenerative branches following pruning is discussed."

Botenkov, V.P. 1979. (Technique for plantations of Scots pine on mountain slopes.) Lesn. Khoz. 4: 29-30. (Ru).
From Forestry Abstracts: "Trials are described in the Eastern Sayan mountains (Krasnoyarsk region, central Siberia) on various ways of controlling weeds in the establishment of plantations on fertile sites. Scots pine seedlings were planted on patches: (a) where the top 5-10 cm of soil were removed by bulldozer; (b) where black polythene film was laid down without any other treatment; and (c), where transparent polythene film was laid down and covered with a thin layer of earth (0.5-1.5 cm). The patches were 1.23 mX1-1.5 m, i.e. 600 patches/ha, and the planting density with 3+0 seedlings was 2000-3000 plants/ha. Data are presented on the physical and chemical properties of the soils, and on the survival and growth of the plants. Survival after 3 yr was 78.3% with (a) and 97.1% with (b) and (c). Height increment was higher on (a) in the year of planting, but thereafter was considerably greater on (b) and (c). Data are presented on the material and labour costs for the three methods. The results indicate that on slopes over 12°, the use of polythene covering (mulching) has

substantial advantages compared with the traditional method of bulldozing cleared patches for planting."

Boudru, M. 1976. (Quercus rubra in the Bois de la Princelle at - Solre-sur-Sambre. A study of a plantation at a wide spacing.) Bull. Sco. R. For. Belg. 83(1): 1-18. (Fr, nl, de, en).
From Forestry Abstracts: "(Cf. FA 37, 2223, 5599) Gives results of two inventories made in 1972 and 1974 (15 and 17 years after planting) in a Q. rubra plantation established at 4X4-m spacing on rather shallow, pebbly, acid brown soil. The data indicate a satisfactory growth rate, with a top height of 12 m 20 years after sowing (site-quality class III, 9 in the La Bastide/Faber yield tables for the Netherlands (cf. FA 35, 2556)). The stand is, however, of poor form, attributable largely to the wide spacing. It has been pruned twice, giving 6 m of clear bole, but pruning is slow, expensive and requires care and skill. The author gives his recommendations for the silviculture of Q. rubra in Belgium; planting stock should be selected by ruthless culling of up to 60% of the nursery seedlings raised, and should be planted when 3 years old at 2X2-m (or possibly 2.5X2.5-m) spacing; worthless trees should be removed by early cleaning; and thinning should be frequent and heavy to favour the best stems and produce broad-crowned trees with clear boles of 6-8 m."

Bowersox, T.W.; Merrill, W. 1976. Stand density and height increment affect incidence of Septoria canker in hybrid poplar. Plant Dis. Rep. 60(10): 835-837.
From Forestry Abstracts: "Severe canker caused by Septoria musiva was present in a 4-year-old plantation of Populus 'NE-49', P. 'NE-252' and P. 'NE-388'. The plantation had been established from cuttings which were given initial growing spaces of 0.09, 0.19, 0.28, 0.37 and 0.46 m^2. Significant differences occurred among clones in incidence of canker; P. 'NE-49' had a greater incidence (67.1%) than P. 'NE-252' and P. 'NE-388' (49.1% and 50.8% respectively). Incidence of canker was positively correlated with initial growing space and third-year height increment. The original stand was harvested at age 4; by the end of the second season after harvest most of the coppice shoots had been killed by the fungus. It is suggested that growing space and height increment interacted to affect the number and longevity of infection courts (leaves, petioles of lower leaves and senescing branches)."

Bozhko, V.E. 1974. (Growth rate of Plantanus orientalis in irrigated conditions.) Lesn. Khoz. 7: 71-73. (Ru).
From Forestry Abstracts: "A summary of account of information on the growth and yield of P. orientalis in irrigated conditions, based on surveys of all the stands in the Ferghana Valley (Soviet Central Asia). The stands are plantations 10-15 years old, and avenue or park plantings up to 100 years old. Data are tabulated on the dimensions and increment of P. orientalis in the various stands, and show that the species is distinguished by its rapid growth in early youth. For the establishment of commercial plantations, a planting density of 3300 trees/ha is recommended. Thinning should start at 10 years, and be repeated at 10-year intervals, removing 25% of the volume. Final felling should take place at 40 years, when the standing volume should be 650-750 m^3/ha."

Braastad, H. 1979. (Growth and stability in a spacing experiment with Picea abies) medd. Nor. Int. Skogforsk. 34(7): 169-215. (No, en).
From Forestry Abstracts: "Performance of Picea abies in Norway (at age 28 yr, top ht. about 10 m) was compared when grown at (four) spacings of: (1) 1.2X1.2; (2) 1.8X1.8; (3) 2.4X2.4; and (4) 3.0X3.0 m. Total yield (av. yield class 9 m^3/ha) and ht. to first live branch decreased from (1) to (4). B.a., mean diam. and branch diam. increased from (1) to (4). Top ht. was lowest in (1) but otherwise n.s.d. Resistance to snow damage (described in detail) increased from (1) to (3)."

Brabander, H.D.; Keuffel, W. 1976. (Spacing and costs of pine plantations. Economic considerations on reforestation of storm damaged areas in Lower Saxony.) Forstarchiv 47(7;8): 129-134; 163-169. (De, en).
From Forestry Abstracts: "Analyses the effect of plant numbers (at 2500 to 25 000 plants/ha) on total costs to age 21 in plantations designed to produce valuable stemwood (pruned) on long rotations (the official policy in Lower Saxony). Problems of labour and capital input, profitability and risk are briefly discussed. Models prepared on the basis of published figures, local records etc., suggest that in the case of Pine any initial savings obtainable from reducing plant numbers are likely to be offset by higher costs for using bigger plants, for replacements, cleaning, protection against game, etc., especially where labour costs are high. Mechanized planting at 10 000 - 20 000 plants/ha is recommended."

Brammanis, L. 1975. (Aradus cinnamomeus, its ecology and significance to forestry.) Stud. For. Suec. No. 123. 81 pp. (De, sv, en).
From Forestry Abstracts: "An account of the history, biology and ecology of this forest insect, only recently recognized as a serious pest of Pinus sylvestris and Larix spp. (cf. FA 34, 5904). Damage to young trees is described; 6- to 10-year-old Pines are particularly susceptible. Control may be achieved by closer spacing at planting, by treatment with N fertilizers or by treatment with lindane."

Brandi, R.M.; Couto, L.; Neto, F. de P. 1977. (Influence of spacing on the survival, frequency of diameter classes and height/diameter ratio in Eucalyptus 'urophylla'.) Rev. Ceres 24(136): 617-627. (Pt, en).
From Forestry Abstracts: "Survival of hybrid (unspecified parentage) E. urophylla in Minas Gerais after 93 months ranged fom 47.1% at a spacing of 2X2 m to 60.5% at 3X4 m. Close spacing gave the largest number of trees per unit area, but with smaller av. diam. Ht./diam. ratio was not influenced by spacing."

Brasil, M.A.M.; Ferreira, M. 1971. (Variations in the basic density of the wood of Eucalyptus alba, E. saligna and E. grandis at five years of age, in relation to site and spacing.) IPEF 2/3: 129-149. (Pt, en).
From Forestry Abstracts: "Comparisons were made of the growth and basic density (b.d.) of the wood of the three species growing at (a) Itupeva, Sao Paulo, on a podzolized gravelly soil that was shallow, acid and infertile, and only moderately well drained, and at (b) Mogi-Guaçu, Sao Paulo, on a red-yellow laterite soil (sandy phase) that was deep and well drained but also acid and infertile; the spacings used were (1) 3X1.5 and (2) 3X2 m. Average d.b.h. at (a) was greatest in E. grandis (13.20±0.11 cm); at (b) the interspecific variations were minimal. Average d.b.h. was not significantly affected by spacing at (a); at (b) it was greatest with (2)

(11.92±0.14 cm). Total height was not influenced by site or spacing, and at (b) was not related to the species; at (a) it was greatest in E. grandis (20.48±0.16 m). At (a), average b.d. was 0.532±0.002 in E. alba, 0.441±0.002 in E. saligna, and 0.407±0.002 in E. grandis, at (b) the respective values were 0.555±0.003, 0.553±0.003, and 0.518±0.003. On neither site was b.d. affected by spacing. The relations between site and b.d. could be attributed either to ecological or to genetic factors."

Bredenkamp, B. 1980. Initial spacing of Pinus patula for maximum yield of pulpwood over a 16-year rotation. South Afr. For. J. 115: 47-49.
From Forestry Abstracts: "Analysis of previously published data showed that vol. production of P. patula on a 16-yr rotation reaches a max. with initial spacings of 2430±620 stems/ha. Expected vol. yields and diam. for a range of spacings are provided."

Brett, P.; Benskin, H. 1978. Guidelines for cost-effective intensive forest management in B.C. Pulp & Paper Canada 79(9): 66-68.
From Forestry Abstracts: "Guidelines are presented for forest land in British Columbia: tree improvement via genetics, and spacing of juvenile trees and commercial thinning to improve crop value at rotation age."

Bunvong Thaiutsa; Wasan Kaitpraneet. 1976. (The observation on ages, dbh, and density of teak at Huay Taak teak plantation, Lampany.) Thailand, Kasetsart Univ. in Bangkok, Fac. For. Res. Note No. 20. 12 pp. (Thai, en).
From Forestry Abstracts: "On the basis of measurements on 13 plots, 40X40 m (1 rai), in Teak (Tectona grandis) plantations of various ages, equations were developed to express the relations between d.b.h. and age, and between number of trees per rai and d.b.h. or age. The equations were used as a guide for thinning."

Burgers, T.F. 1971. The correlated curve trend (C.C.T.) method used for growth prediction in thinned stands of Pinus patula. Forestry in South Af. 12: 11-17. (En, af).
From Forestry Abstracts: "Describes a simplification of the CCT method based on the empirical fact that the mean d.b.h. increment of a thinned stand is equal to that of an unthinned stand of the same density (stems/acre) and b.a., over a period of ±4 years. The need for main taining a series of thinned plots is thus eliminated. The mean d.b.h. increment of S. African stands of 50-1700 stems/acre are shown in a graph for ages up to 40 years. Another graph shows the 'arithmetic increase', i.e. the difference between the mean d.b.h. of the stand before and after thinning, and the 'arithmetic decrease', i.e. the difference between mean d.b.h. before thinning and the mean d.b.h. of the trees removed in thinning. Mean height curves are also given; height growth is fastest at 150-300 stems/acre."

Burns, R.M.; Brendemuehl, R.H. 1978. Sand pine: early responses to row thinning. USDA, Forest Serv., Southeast For. Exp. Sta. Res. Note SE-262. 8 pp.
From Forestry Abstracts: "Plots in 2 Pinus clausa plantations planted at 7X7 ft spacing in 1955 were thinned in 1970 by removing (a) every second row or (b) every fourth row, together with removal of stunted, injured or malformed trees from remaining rows. Survival and growth of thinned and

unthinned plots were measured in 1970-75. Ht. increment decreased and diam. and vol. increment increased with increased thinning intensity. In 1975, vol./acre and b.a./acre were greater on unthinned than on thinned plots."

Burschel, P. 1981. (New concepts for the growing of (pure) Norway spruce stands.) Allg. Forstz. 51/52/53: 1386-1395. (De).
From Forestry Abstracts: "A comprehensive review, including the work of Pollanschutz/Johann (thinning from below), Abetz (initial free thinning followed by thinning from below at later stages), and others. The new concepts are characterized by: relatively low stem number at stand establishment (2500-3300 stems/ha); concentration of thinning operations in the first 1/2 of the rotation period: and no fellings in the last 1/3 of the rotation period. Advantages of the methods (based in part on evaluations of growth simulation models) include: increased vol. production; improved timber quality (branchiness is not a problem unless stem number falls below about 2000 trees/ha at top ht. 15-20 m); and improved stand stability (including reduction in ht./diam. ratios, thereby reducing risk of snowbreak)."

Burschel, P.; Franz, F.; Pechmann, H. von; Kroth, W. 1974. ((I) Modern ideas on thinning, exemplified by models of spruce stands. (II) Advanced thinning methods and yield. (III) Influence of thinning on wood quality. (IV) Economic aspects of thinning.) Forstarchiv 45(2/3): 21-42. (De, en).
From Forestry Abstracts: "Papers (I), (II), and (IV) discuss the development of volume and financial yields of pure Spruce stands on the basis of simulated models assuming a top height of 32 m, a 100-year rotation, three initial spacings (3000, 5000 or 10 000 plants/ha) and three thinning schedules: a traditional moderate thinning leading to 575 final crop trees (a); a 'differentiated thinning' concentrated chiefly in the ages <35 years and leading to a similar number of crop trees (b); and a stem number thinning schedule (c) (cf. Abetz 1973) based on stem-number/top-height relations, with heavy stem number reductions in the second half of the rotation, the final number of 400 crop trees being reached at stand height 25-28 m. It is concluded that wide initial spacings, and thinnings of the (b) or (c) type, are likely to lead to the highest volume and/or financial yields, and that such treatments are acceptable from the point of view of stand stability and wood quality. (III) Discusses the influence of degrees and intervals of thinning on quality in softwoods and hardwoods, and includes some data from studies with Spruce, Douglas Fir, and Beech where early and heavy thinning had had no adverse effect on wood density, though excessively rapid thinning had led to resin pockets, shakes, etc."

Campbell, R.K.; Wilson, B.C. 1973. Spacing-genotype interaction in Douglas fir. Silvae Genet. 22(1/2): 15-20.
From Forestry Abstracts: "A spacing/genotype interaction, present in a Douglas Fir seedling test, did not involve rank changes of family performance at different spacings. The significant interaction can be attributed to changes in trait variance at different spacings and is eliminated by an appropriate transformation. Test materials were 3-year-old seedlings of 30 families from a 5-males-within-6-females Design I mating grown at four spacings (1, 3, 5, and 7 inches apart) in a nursery. Growth response of

seedlings to spacings was subjectively compared (i.e., no statements of statistical reliability were possible) with responses in 43-year-old Douglas Fir and with responses in several crop and forage species. In terms of effect of spacing on relative variability, on shapes of frequency distributions, and on vegetative yield, seedlings and mature trees performed similarly to one another and to several agricultural species. On the assumption that similar responses to density imply similar types of genotype/spacing interaction, spacing/genotype interaction in Douglas Fir is not likely appreciably to affect selection accuracy, particularly if individual tree data are transformed to a scale which normalizes their distribution."

Carretero, R.V. 1972. ("Study of the behaviour and yield of an irrigated poplar plantation in Tenuyan valley, Mendoza province, Argentina.) Univ. Nacional de Cuyo, Rev. Fac. Ciencias Agrarias 18(1): 33-47. (Es, en).
From Forestry Abstracts: "Thinning plots were established at four years of age in two plantations consisting mainly of Populus 'I-214', one plantation being of satisfactory vigour with an initial spacing of 7X1 m, and the other of unsatisfactory vigour with an initial spacing of 6X1 m. Three thinning treatments were applied in the fifth and tenth years: (A) control, no thinning; (B) medium thinning; and (C) heavy thinning. Details are given of the performance of the plantations up to 16 years, when the number of trees/ha was 800 on the (B) plots and 500 on the (C) plots. At 16 years, the m.a.i. in the better stand was 17.5 m^3/ha for (A), 27.7 m^3/ha for (B), and 28.9 m^3/ha for (C); corresponding values for the poorer stand were 10.3, 17.5 and 19.1 m^3/ha."

Cesar, S.F. 1977. (Spacing forest crops.) Brazil, Sao Paulo, Inst. Florest. Publ. 15: 50-59. (Pt).
From Forestry Abstracts: "The effects of different spacing distances upon tree growth are described, with respect to ring width, crown development, wood quality, volume production, survival etc. Some advantages and disadvantages of wide spacing are listed."

Chamshama, S.A.O.; Philip, M.S. 1980. Thinning Pinus patula plantations at Sao Hill, southern Tanzania. Univ. Dar es Salaam, Div. For., Rec. No. 13. 16 pp.
From Forestry Abstracts: "The object of the study was to provide information on the effects of past and present thinning schedules. Stands were thinned from 1680 stems/ha at planting to 370 stems/ha at a rotation age of 30. Sample plots were sited in 24 stands of ages between 4 and 27 yr. Sample trees were measured for d.b.h., ht. and stem quality. The data were analysed for standing yield, stand density, stems/ha, mean diam., dominant ht. and stem quality. Results showed that there was a high % of good quality stems but densities exceeded those prescribed in the thinning schedules. There was no loss in total yield but diam. growth was reduced. From authors' summary."

Chavasse, C.G.R.; Balneares, J.M.; Bowles, G.P. 1981. Blanking plantations of radiata pine. N.Z.J. For. 26(1): 55-69.
From Forestry Abstracts: "Trials were carried out from 1963-1978 to determine the effects of replanting blanks in plantations originally established at spacings of 2.4X1.8 m or 3.6X1.8 m. Filling blanks in the summer or winter after planting had no effect on ht, d.b.h. or branch size of the

original crop. In all stands, the original trees were significantly larger than replacement trees; larger, older 'blanking' stocks grew slightly better than smaller stock. 'Blanking' is therefore not recommended except for gaps of 100 m² or more."

Chistyakov, A.R.; Gerasimov, V.T. 1979. (Effect of thinnings on the growth of young aspen stands.) Lesn. Khoz. 2: 29-31. (Ru).
From Forestry Abstracts: "Permanent thinning plots were established in 1963-64 in 7- and 8-yr-old stands of Populus tremula, of sucker origin, in the Mari ASSR. Heavy, medium, and light thinnings were carried out, removing 51, 30-34 and 10% of the trees, and the results were followed for 11-12 yr. Studies were also made of light and moderate thinnings removing 13 and 21% of the standing volume, in a 17-yr-old stand. Data are tabulated on the mensurational details of the plots in 1964 and 1975, and on the branchiness of the stems. Natural thinning proceeds vigorously in young aspen stands of sucker origin, and initial densities of 25 000-30 000 plants/ha may be reduced to only about 3000 trees/ha by age 17-20 yr on the best sites. It is recommended that thinning be done so as to leave 6000-7000 trees/ha at 7-10 yr on site class II and 4000-5000 trees/ha on site classes I-Ia. The next thinning at 15-17 yr should leave 3000-4000 trees/ha on site class II and 2000-3000 trees/ha on site classes I-Ia."

Choong, E.T.; Chang, B.Y. 1974. Effect of cultural treatments on density and growth in loblolly pine plantation. La. State Univ. Wood Util. Notes No. 25. 4 pp.
From Forestry Abstracts: "Reports a study of the effects of initial spacing and of pruning and thinning treatments on the sp.gr. and growth (radial increment) of Pinus taeda as assessed at 22 years of age in a Louisiana plantation. Spacing had a significant effect on radial growth rate, the greatest growth occurring at the widest spacing. Thinning at age 5 had no effect on growth; the effect of pruning, however, was significant five years after treatment. Thinning at age 11 had a significant effect on growth. Growth was least in the unthinned plots. Thinning had no significant effect on sp.gr. (some difference in sp.gr. after thinning is attributed to the influence of spacing before thinning)."

Chroust, L. 1973. (Effect of row thinning on the microclimate of young Scots pine stands.) Lesnictoi 19(7): 567-582. (Cs, ru, en, de, fr).
From Forestry Abstracts: "Plots in a 9-year Scots Pine plantation were thinned by removing either alternate pairs of rows (where the spacing was 0.8X0.8 m) or every fourth row (spacing 1.0X1.0 m), in both cases reducing numbers to 7000 trees/ha as compared with 15 000 trees/ha on an unthinned control plot. Comparative data from measurements made in the following year on interception, evaporation, air and soil temperatures and soil moisture are presented and discussed, and it is concluded that, in general, row thinning has a favourable effect on microclimate."

Clark, P.M.; Williams, R.D. 1979. Black walnut growth increased when interplanted with nitrogen fixing shrubs and trees. Proc. Indiana Acad. Sc. 88: 88-91.
From Forestry Abstracts: "Black walnuts (1 yr old) were planted at 11X11 ft spacing at a site in S. Indiana, in 1967. Two yr later they were interplanted with autumn olive (Elaeagnus umbellata), European alder (Alnus glutinosa) or black locust (Robinia pseudocacia), or broadcast- sown with

Lespedeza striata. Weeds were controlled with amaxine in all except the lespedeza plots, and in 1973 the locust trees were killed because they were overtopping the walnuts. No consistent pattern of improved growth was observed until 1975. From 1975 until the end of the study in 1978, ht. and diam. of walnuts grown with autumn olive were significantly greater than in other treatments, although European alder and black locust also increased growth. The lespedeza failed to establish, even after resowing. Walnuts in control plots were not as straight and required more pruning than those grown with nurse trees."

Coelho, A.S.R. 1971. (The response of Eucalyptus spp. to different initial spacings.) In (Proceedings of the First Argentine Forest Congress - 6 to 11 October, 1969.) (Es or Pt).
From Forestry Abstracts: "Gives the results of trials with E. grandis, E. saligna, E. alba and E. propinqua at two forest nurseries in Sao Paulo."

Coelho, A.S.R.; Mello, H.A.; Simoes, J.W. 1970. (The behaviour of Eucalyptus spp. in relation to spacing.) IPEF 1: 29-55. (Pt, en).
From Forestry Abstracts: "Plantations of E. grandis, E. saligna, E. alba and E. propinqua were established at the Horto da Mina, Itepuva, Sao Paulo, Brazil, to compare the effects of spacing at 3X2 m (a) and 3X1.5 m (b), under rotations of 5, 7, 9 and 11 years. Total height and d.b.h. were measured for the first four years, and the results of 5 years' growth are presented. Height growth was unaffected by spacing, except for 3- and 4-year-old E. grandis where it was greater with (a). Plantations at spacing (a) were one year ahead of those at spacing (b) in diameter increment. There were interspecific differences in response to spacing. Stacked volume of unbarked wood at 5 years was generally greater with (a), but the yield in terms of dry weight of wood did not differ between treatments (a) and (b). E. grandis showed great promise for management under short rotations on sites of this type."

Cook, D.B. 1974. Unexpected results from larch trials. J. For. 72(9): 567-577.
From Forestry Abstracts: "Briefly describes the results of a trial with alternate rows of Japanese and European Larch in the author's experimental Cooxrox Forest, New York. The European Larch stock was unsuitable and failed; the Japanese Larch, left at the unusual spacing of 6X20 ft, developed into a good stand with adequate stocking. In the light of this experience, a stand of Japanese Larch was planted at 7X12-ft spacing (instead of the author's usual 6X10 ft) with significant savings in the cost of planting and clearing."

Couto, H.T.Z. Do; Mello, H.A.; Simoes, J.W.; Vencovsky, R. 1973. (Coppice management of Eucalyptus saligna.) IPEF 7: 115-123. (Pt, en).
From Forestry Abstracts: "Compares stool survival, sprout dimensions and fuelwood volume produced in three methods of coppice management in Sao Paulo, Brazil, viz. with 1, 2, or 3 sprouts per stool in a plantation originally spaced at 2X2 m. Stool survival was not affected by the number of sprouts. The yield of stacked fuelwood was smallest with 1 sprout per stool and greatest with 3 sprouts per stool. There was little difference in the yield from 2 and 3 sprouts per stool, and the treatment with 2 sprouts per stool is recommended, since the diameter of the wood produced is greater.

Cox, F. 1971. (Determination of stand density and structure of plant populations on the basis of distance measurements: a contribution to methods for regeneration surveys.) Mitt. Bundesforschugsanst. Forst- & Holzw. No. 87. x+182 pp. (De, en).
From Forestry Abstracts: "Reviews existing methods for determining the density and spatial distribution of plants, including distance methods and stocked-quadrant methods, and proposes a new system of estimating stem number, based on a computer simulation of sampling, with 15 models of different spatial distributions, involving measurements from a sampling point to the nearest 6 individuals or to the nearest 3 individuals in a quadrant. The estimator H_6, obtained from the harmonic mean of distance to the sixth individual, and also the estimator H(H), (harmonic mean of harmonic means of distances to the third individual in quadrants) provided acceptable estimates for systematic, random, and moderately clustered distributions. A more complicated quadratic harmonic mean of distances within four quadrants was suitable for very heterogeneous or clustered structures. A method is presented for the description of spatial distribution, based on the size and % of circular zero (unstocked) plots and an estimate of stem numbers. A zero-plot diagram is developed and its application to the evaluation of a regeneration area and the probable future distribution of crop trees is illustrated. Further applications are discussed."

Cozzo, D. 1974. (The growth of Eucalyptus globulus, E. viminalis and E. camaldulensis in the NE corner of Punto Indio in Buenos Aires province.) Rev. For. Argent. 18(1): 27-28. (Es).
From Forestry Abstracts: "A note on the performance of two mixed plantations, both 20 years old, established at an initial spacing of 2X2 m on a site with a calcareous pan limiting the rooting depth to a maximum of 70-90 cm and in places to 20-30 cm. The m.a.i. increased with soil depth, the maximum being 30 m^3/ha for E. globulus, 33.5 m^3/ha for E. viminalis, and 28 m^3/ha for E. camaldulensis."

Crist, J.B.; Dawson, D.H. 1975. Anatomy and dry weight of two Populus clones grown under intensive culture. USDA, Forest Serv., North Cent. For. Exp. Sta. Res. Pap. NC-113. 6 pp.
From Forestry Abstracts: "Cuttings of Populus 'Tristis No. 1' and P. 'Northwest' were planted at three spacings (9X9, 12X12 and 24X24 m) in summer 1970. In autumn 1971 the dry weights of aerial parts (including leaves) and anatomical characters of the stem wood and bark were determined. Results (tabulated) show that both clones produced high yields of material of acceptable quality. Variations between the clones in yield and quality illustrate that selection of genetic material and growing conditions are significant factors in maximum-yield short-rotation systems."

Crowther, R.E. 1977. Short-rotation coppice-time for a revival? Forest and Timber 6(4): 42-43.
From Forestry Abstracts: "Hardwood 'silage' rotations of 1-5 yr at close spacing regenerated by coppice have been reported from Canada and USA. Results of work at Ontario on varieties (clones) of hybrid poplar (Populus X canadensis) are compared with data for poplar clones at Alice Holt Forest, UK. In both cheap setts are planted at close spacing (unspecified), fast growth leads to early exclusion of weeds, and the total wood

production is utilized. Large volumes of wood chips could be produced by growing such selected clones on short rotations. Harvesting, growing costs, land availability, alternative species (Salix spp., Alnus rubra) and marketing prospects are discussed."

Cruwys, G.E. 1972. Precision planting - an economy in management with the aim of producing a final hardwood crop. Timber Grower 45: 20-24.
From Forestry Abstracts: "Describes a simple method of planting at an exact 2X2-m spacing (with straight lines vertical and horizontal in plan), that will allow line thinning along diagonals. A mixed stand was established in this way: Tsuga heterophylla, with Nothofagus procera as every fourth tree in every fourth row. The first thinning will remove every fourth diagonal row, and the second thinning every second diagonal row, leaving all the N. procera standing. At the third thinning alternate vertical rows are removed, leaving 250 trees/acre, spaced 4X4 m, of which 62 are N. procera and 188 are T. heterophylla. The intention is to fell all the T. heterophylla at 50 years and underplant, felling the original N. procera at 100 years, along with the second crop of T. heterophylla."

Curtis, R.O.; Reukema, D.L.; Silen, R.R.; Fight, R.; Romancier, R.M. 1974. Intensive management of Douglas fir. For. Ind. 101(11): 48-50.
From Forestry Abstracts: "Discusses the scope for intensive silviculture in second-growth and young stands in the Pacific Northwest Region, with special reference to control of spacing and competition, the improvement of soil fertility, and genetic improvement. Facts limiting intensive management are also discussed."

Dagenbach, H. 1978. (First results of a Douglas fir grading experiment 7 years after planting.) German Federal Republic, Forstl. Versuchs-und Forschungs-anst. Baden-Württenberg, Mitt., Verein Forstl. Standortskunde une Forstpflanzenzüchtung. No. 26: 68-69. (De, en).
From Forestry Abstracts: "Some 500 seedlings of Shuswap Lake provenance were sorted into 3 grades (large, medium and small) by ht. and root- collar diam. At 7 yr after planting (on a cold afforestation site at 2X2 m spacing), the differences in growth persisted. Under the extreme conditions of the trial, replacing all the lowest grade by large or medium stock would have given net savings in plantation tending costs."

Dawson, D.H.; Isebrands, J.G.; Gordon, J.C. 1976. Growth, dry weight yields, and specific gravity of 3-year-old Populus grown under intensive culture. USDA, For. Serv., North Cent. For. Exp. Sta. Res. Pap. NC-122. 7 pp.
From Forestry Abstracts: "Populus 'Tristis No. 1' was grown from cuttings, under near optimum conditions, in an irrigated nursery in Wisconsin in 1970-72. Three plant spacings were tested: 9 mX9 in.; 12 inX12 in.; and 24 inX24 in. The most widely spacing trees attained the greatest height, but the most closely spaced trees gave the greatest annual production of wood, over 4 tons/acre, and had the highest ratio of stem:total dry weight. The yields obtained exceed those reported for natural and planted Populus stands. Wood density was unrelated to stocking."

Day, R.J.; Raalte, G.D. van. 1970. Some relationships between spacing, foliar weight and volume increment in balsam fir (Abies balsamea (L.) Mill.). Univ. Toronto, Fac. For., Exts. from Rep. Res. For. Bot. Glendon Hall 1969/70. Pp. 6-7.

From Forestry Abstracts: "A study of 48 trees showed that foliage weight was poorly correlated with spacing and intercrown distance. Periodic volume increment was found to be closely related to foliage weight but, as the tree ages, stem volume increment per unit weight of foliage decreases. The study shows that spacing and intercrown distance are poor measures of competition in a tolerant spacies such as A. balsamea."

Dearborn, M. 1976. Black walnuts in pig farming. Farm For. 18(4): 107-109.
From Forestry Abstracts: "Black Walnut (Juglans nigra) can produce a high quality veneer crop in 25-30 yr. Deep, well-drained soil is needed. Complete weed control is essential for the first 3 yr, but intercropping is possible if moisture is adequate and the trees are not shaded. Spacing for timber production should be 3.4X3.4 m to 5.5-5.5 m. First pruning should be done at 3-4 yr and 8-10 cm d.b.h. Self-pruning occurs when limbs touch. A clear log 10-15 m long can be produced."

Decei, I.; Armasescu, S. 1980. (Mensurational characteristics of hybrid black poplar plantations in Romania.) Bull. Acad. Sc. Agric. For. No. 9: 211-223. (Fr).
From Forestry Abstracts: "Data are summarized in tables for plantations up to 14 yr old (the age of culmination of vol. m.a.i.) of (a) Populus 'I-214' and (b) P. 'R-16' (a local provenance of P. 'Robusta') planted at spacings of 4X4, 5X5 and 6X6 m, and of (c) 'unselected' clones, viz. P. 'Marilandica', P. 'Regenerata' and P. 'Serotina' as a group, planted at 2X2, 3X3 and 4X4 m spacing. With wider spacings, the mean d.b.h. increased, mean ht. was unchanged and total vol. yield decreased. The mean d.b.h. of (a) was consistently 6% greater than that of (b). For max. yield, (a) and (b) should be planted at 4X4 m and either left unthinned or selectively thinned with removal of not more than 20% of the stem numbers. Comparable yields can be obtained with (c) at 3X3 m spacing or (on class I sites) 2X2 m."

Decourt, N.; Lemoine, M. 1974. (First results of a clinal spacing experiment with Populus trichocarpa.) Ann. Sc. For. 31(3): 171-179. (Fr, en, de).
From Forestry Abstracts: "Describes the use of a 'clinal' lay-out (explained and illustrated diagrammatically) in an experiment to determine the effects of a progressive increase in spacing, from 1.0 to 5.96 m, on height and diameter growth during the first few years in a plantation of P. trichocarpa 'Fritzi Pauley', and discusses the advantages of the lay-out for this type of experiment. The results show clearly that, with this Poplar, spacings of 2.50 and 3 m have no adverse effect on increment in height and girth respectively, six years after planting. The design, first described by J.A. Nelder (see Biometrics (1962) 18 (3), 283-307), was also used in an experiment, already reported, on density and competition in P. pinaster stands."

Dekanic, I. 1973. (Pulpwood production by various hybrid black poplars grown by different methods.) Topola 17(98/99): 43-45. (Sh, fr).
From Forestry Abstracts: "Tabulates data on the per-hectare volume production of pulpwood to an 8-cm top diamter u.b. by various hybrid Black Poplars ('Serotina', 'Marilandica', 'Robusta', 'Regenerata', and 'I-214') grown at different stand densities up to age 5 or 6 years in Yugoslavia. No conclusions or recommendations are drawn."

Delvaux, J. 1970. (The development of stands. IX. Social conditioning of the individual growth of young Picea abies.) Trav. Sta. Rech. Groenendaal (Ser. B) No. 35. 45 pp. (Fr).
From Forestry Abstracts: "Describes an experiment made in a dense stand of 4-year-old Spruce (15 000-16 000 trees, spaced 33X10 cm), which was divided into lots of 15 trees, in some of which all trees were removed by cutting at ground level, except the tallest tree (dominant) or the tree of median height (median). In the first growing season immediately after treatment, the diameter growth of dominant and median trees on treated plots was markedly stimulated, as was their height growth in the second growing season. The relative stimulation of growth in the median trees was greater than that in the dominants, but the absolute increment of medians and dominants was not significantly different. At the end of 3 years, individuals subjected to the same treatment resembled one another much more closely than did individuals of the same initial status that had received different treatments. It is concluded that only obviously valueless planting stock should be eliminated in nurseries. Under forest conditions, the observations would favour thinning from above rather than from below. The recognition of truly elite trees would be more reliably achieved in carefully tended plantations at wide spacing than in dense plantations. Diameter, diameter increment, and height are imperfect as individual genetic criteria, particularly in stands originating from natural reproduction or dense planting. Individual differences observed within a stand are much less reliable than those relating to the comparative behaviour of two stands."

Delvaux, J. 1971. (The development of stands. X. Inter-tree competition in Pseudotsuga menziesii var. menziesii.) Trav. Sta. Rech. Groenendaal (Ser. B) No. 36, 23 pp. (Fr).
From Forestry Abstracts: "Experimental plots were laid out in 1963, with 2+0 Douglas Fir seedlings planted at spacings ranging from 0.1X0.1 to 1X1 m., in order to determine the effects of inter-tree competition on increment. Observations were made over the period 1963-1969. Results indicated that: (1) individual height, diameter and volume of young trees (8 years old) is depressed by very low or very high densities, optimum increment occurring at a spacing of ca. 1/2 tree height; (2) volume increment per unit area culminates at considerably higher densities than those corresponding to maximum increment of individual trees; and (3) the behaviour and order of magnitude of the increments observed in very young stands are almost identical with those observed for older forest stands; hence 'miniature' experiments can be used to study a large range of silvicultural problems."

Delvaux, J. 1973. (Combining utility with amenity: a plot in the geographic arboretum at Bouillon (S. Belgium).) Bull. Soc. R. For. Belg. 80(1): 17-22. (Fr).
From Forestry Abstracts: "Describes the present state of an experimental plot, planted on a steep slope soon after 1900 with groups of coniferous species from the W. side of the Cascade mountains, Oregon, and now for the most part invaded by the natural woody vegetation. A surviving small stand of 66 remarkably fine Douglas Fir trees, planted at a wide spacing and now at a density equivalent to 183 stems/ha, is of particular interest; it is not being invaded, its growth rate is good, and the trees are perfectly stable in spite of the steep slope and stony soil with patches of scree.

The possibility of converting coppice on similar sites by planting Douglas Fir at a wide spacing deserves consideration."

Delvaux, J. 1974. (The development of stand. XIII- Numerical thinning tables.) Belgium, Travaux, Sta. Rech. Eaux et For., No. 38. 31 pp.+33 sets of tabl. (Fr).
From Forestry Abstracts: "Discusses the purpose and construction of numerical thinning tables and presents a series of loose-leaf tables giving the number of stems/ha compatible with different stand conditions as reflected by a wide range of combinations of the following parameters: (a) number of stems/ha (100 to 10 000); (b) diameter of the stem of mean b.a. (2 to 50 cm); (c) m.a.i. in diameter (1 to 50 mm); (d) thinning interval (1, 3, 6, 12 and 24 years); and (e) annual b.a. increment per ha (0.2 to 4 m^2) - within values for (d)X(c) of ca. 1-10."

Delvaux, J. 1975. (Stand tending. XIV. - Acquisition of social rank in young spruce plantations. XV. - Outline of economic production of plantations in relation to density.) Belgium, Travaux, Sta. Rech. Eaux For., No. 39. 32+12 pp. (Fr, en).
From Forestry Abstracts: "Pt XIV reviews the literature on the ranking of individual trees from the nursery stage to the established plantation, with reference to the relation between genotype and phenotype. An experiment is described in which Picea abies was planted at two very different spacings (0.30X0.33 m and 1.5X1.5 m) and 'disturbances in the hierachy' were studied. It was found that at close spacing (intense competition) the natural hierachy was very stable, whereas accidental disturbances of it continued for a long time at the wide spacing. The implications for selection in tree breeding are discussed. Pt XV uses the data from the experiment described in Pt XIV as the basis for a discussion of the great importance of early stand tending, and its long-term consequences for the value of the wood produced."

Delvaux, J. 1975. (Stand tending. XVI. - Thinning European larch (Larix decidua). Study in miniature of thinning intensity and of the periodicity of improvement fellings, on a rotation of 6 years (1968-1973).) Belgium, Publ. des Hors Sçrie, Sta. Rech. Eaux et For., No. 78, 18 pp. (Fr, en, de).
From Forestry Abstracts: "A 'miniaturization' experiment is described in which 25 plots, each containing 100 plants, at an initial spacing of 0.3X0.4 m, were subjected to two thinning intensities on a 'short' (1 yr) and a 'long' (2 yr) cycle, or left unthinned (control). The results agree with those of full-scale thinning experiments as to the effect of thinning on ht., b.a. and vol. increment etc., indicating that in future miniature experiments could be used instead of full scale thinning trials, to test other methods."

Delvaux, J. 1981. (Sociological differentiation.) Schweiz. Z. Forstwes. 132(9): 733-749. (Fr, de).
From Forestry Abstracts: "A review of a series of experiments on the development of sociological structure, and growth at various spacings, in nursery/plantation-grown young spruce in Belgium. The gradual differentiation was demonstrated of spruce in a plantation into discrete groupings based on ht. over the period 1955-1962. Median and dominant ht. and diam. were greater when spruce were grown under less severe intraspecific

competition than under greater competition (related to close spacing). It is concluded that phenotypic differences in young spruce plants immediately after planting are very often due more to accidents during lifting and/or microenvironmental differences in seedbed/nursery than to genotype; after outplanting, a period of reconciliation of phenotype to genotype occurs, leading to marked sociological regrouping, which is largely maintained after intraspecific competition becomes a dominating factor as the plantation ages. It is recommended that wider, rather than narrower, spacings be employed in order to aid in the identification of individuals with the greatest natural growth potential as candidates for artificial selection."

Delwaulle, J.C. 1979. (Forest plantations in dry tropical Africa. Techniques and species to use (IV).) Bois For. Trop. 184: 45-59. (Fr, en, es).
From Forestry Abstracts: "Spacing trails are described, in which Nelder's experimental design (concentric circles) was used. The theory of the Marynen and Marchal designs is also discussed. Data are given for a trial with Eucalyptus camaldulensis in Upper Volta, and with neem in Niger. In general spacings of 3X3 m to 5X5 m are recommended in rainfall zones of 950 to 600 mm p.a. respectively.

Planting layouts in squares, rectangles, triangles or in quincunx are briefly discussed.

Various fertilizer trials with eucalypts, neem, Dalbergia sissoo and Prosopis juliflora, in Senegal, Upper Volta and Niger are reported and discussed. The importance of B deficiency in eucalypts is emphasized."

Denev, D.A. 1974. (Growth and yield of fertilized and irrigated poplar plantations.) Gorskostop. Nauka 11(5): 53-62. (Bg, ru, de).
From Forestry Abstracts: "Describes studies on the effects of NPK fertilizers and irrigation in a stand of Populus 'Vernirubens' established in 1966 at a spacing of 5X5 m on a drained site 3.3 m above the mean level of the Danube in Bulgaria. Fertilizing without irrigation had little effect on growth. NPK fertilizers plus irrigation had the best effect, but as NPK was only slightly superior to NP, the use of NP plus irrigation in the second half of the growing season is recommended."

Dik, E.J. 1975. (Thinning trials in young larch stands.) Ned. Bosbouw Tydschr. 47(5): 139-148. (Nl, en).
From Forestry Abstracts: "Describes trials in Japanese Larch plantations (spacing 1.5X1.5 m) in the Netherlands to compare four thinning treatments at 6 years, viz. no thinning (4400 trees/ha), and selective thinning to 3200, 2900 and 2200 trees/ha, and also to compare a 50% row thinning carried out at ages 6, 7, 8, or 9 years. Results showed that early heavy thinning (50% removal) gave the best results. Thinning should be done before the dominant height reaches 6 m."

Dimitrov, Kh.; Broshchilov, K. 1979. (Growth, yield and plant spacing of woody species in shelterbelts in Southern Dobrudzha.) Gorskostop. Nauka 16(6): 16-26. (Bg, ru, en).
From Forestry Abstracts: "Studies were made on shelterbelts established in 1955-56 in the Dobrudzha region of Bulgaria. The main species involved are Quercus cerris, Ulmus pumila, Gleditsia triacanthos, Fraxinus oxycarpa, Q. rubra, Q. robur and Robinia pseudoacacia, in various combinations and with

various associate species such as Acer tataricum, A. campestre, Tilia argentea, Prunus mahaleb and F. pennsylvanica. The performance of these species up to age 22 at various spacings is shown in tables and graphs. The best growth at 20 yr is shown by Q. rubra, G. triacanthos and F. oxycarpa among the main species, and by T. argentea among the associate species. The best yield at 21-22 yr is shown by Q. rubra, pure or in mixture with T. argentea, viz. 150-200 m³/ha. An initial spacing of 1.3X2.25 m is best, except for G. triacanthos, which does best with a spacing of 1.3X0.75 m."

Dittmar, O. 1975. (Silvicultural and yield-study results of 30-year-old Pinus sylvestris spacing trials in the Eberswalde forest enterprise.) Soz. Forstwirt. 25(8). (De).
From Forestry Abstracts: "A fairly detailed report on three trials on sandy sites of high or medium fertility, the trials on median sites being combined with provenance trials, concluding that very high densities are required for quality timber on fertile sites, and that cold-climate or eastern provenances show promise for quality timber at lower densities."

Dittmar, O. 1977. (Results of the international pine provenance tests. Chorin 85 and Finowtal 145 after 66 and 36 years, respectively.) Beitr. Forstwirt. 11(3): 116-119. (De, Ru, En).
From Forestry Abstracts: "(In a trial at Chorin assessed at age 66 years, pines (Pinus sylvestris) from Brandenburg, German Democratic Republic and Masuren, Poland had the best site class data and total stem yield, followed by those from Belgium, Latvia and the Rhineland Palatinate; those from Scotland and S. France were inferior. In a combined provenance and spacing trial at Finowtal, assessed at age 36 years, the quality of the pine stand was influenced more by spacing than by provenance. A narrow spacing 0.3X0.3 m, gave better quality timber than spacing at 1X1 m. The wider spacing was superior with regard to most parameters of growth and yield but narrow spacing gave a higher b.a. and vol."

Dittmar, O.; Knapp, E.; Kohlstock, N. 1974. (Performance evaluation of various rationalized methods of cleaning and thinning in young Picea abies stands after a 10-year trial period.) Soz. Forstwirt. 24(11): 334-335. (De, ru, en, fr).
From Forestry Abstracts: "Describes several treatments begun in 1962-64 in stands initially 12-31 years old on good sites in the E. Harz and Thuringia, and examines the main results from the aspects of increment, branch size, total yield, net revenue from thinnings, mortality, and barking by red deer. The most economic and silviculturally acceptable régime was that beginning with heavy thinning in the Christmas-tree (thicket) stage (leaving a residual stand of 2500-2800 stems/ha). In stands untended until ≥20 years old, the preferred régime was that of heavy thinning (to ca. 2200-2300 stems/ha) on reaching merchantable size. Very heavy thinning régimes resulted in significant yield losses. The first thinning can be delayed to ca. 40 years old on the less productive Spruce sites, which should therefore be planted at a spacing of 2X1.5 m."

Divoux, A.; Pardé, J. 1980. (An interesting reference: the spruce plantation at Servon-Saint-Thomas (Marne).) Rev. For. Fr. 32(4): 373-378. (Fr).

From Forestry Abstracts: "The plantation was established on battlefields of the first world war near Argonne between 1930 and 1933 with, as principal species: Picea excelsa (P. abies) (55%), Larix leptolepis (10%), Pinus sylvestris (5%) and Pseudotsuga menziesii (5%). A trial was started in 1954 to assess the productivity of P. abies by examining the effects of 3 thinning regimes (heavy, medium and light). Results are tabulated for 1959, 1964, 1969 and 1978 by number of stems, b.a., mean and dominant ht., and vol. for the trees before and after thinning and for those harvested. At age 50 yr m.a.i. was between 14 and 15 m^3/ha. Using the results from the trial, stocking at 5 000 stems/ha and thinning to 1 200 by age 50 yr is recommended for plantations of this type. This regime would yield 210-220 m^3/ha over 50 yr. Contrary to published findings (see FA 41, 269), the form factor was found to increase with age, and not remain constant."

Dohrenbusch, A.; Röhrig, E. 1981. (A planting trial with Abies grandis.) Forstarchiv 52(3): 86-92. (De, en).
From Forestry Abstracts: "Growth was observed in plants established at 3 sites in Lower Saxony in spring 1974 (spacing 1X1 or 2X1.5 m), including (a) 1+2 bare-rooted plants and container-grown plants, viz. (b) 1+1 plants in Nisula rolls, (c) 2+0 plants in 90 cm^3 conical containers, and (d) 1+2 plants in 500 cm^3 'GL-1' pots; results are presented up to 1977 and 1980 (one site only). Although there were initial differences in ht. between treatments, after 7 yr treatments were n.s.d. in relation to ht. or diam. Shoot/root ratios were relatively high in (a) and (b), and below av. in (d) and especially (c). Characteristic root deformations were observed in both bare-rooted and container-grown plants. Observations on bud phenology, including prolepsis, are discussed."

Donald, D.G.M.; Schutz, C.J. 1977. The response of Eucalyptus to fertilizer application at planting: the Louw's Creek trial. So. Afr. For. J. 102: 23-28. (En, af).
From Forestry Abstracts: "In fertilizer trials with E. grandis started in 1964 in South Africa, in which growth was significantly improved at 3 yr 8 months, the unfertilized control yielded as much as any treatment on clear felling at 9 yr 3 months. Form factor and wood properties were unaffected, but stand uniformity was improved by a high N/P ratio fertilizer. At the close spacing used (2.13X2.13 m), competition for moisture and light becomes the main limiting factor. It is concluded that the fertilizer should be only enough to ensure rapid canopy closure, e.g. 273 kg/ha of 3:2:1."

Dotsenko, A.P. 1981. (Plantation growth of Picea abies in Byelorussia.) Lesn. Khoz. 4: 26-28. (Ru).
From Forestry Abstracts: "A summary account of experience in Byelorussia with intensively managed plantations of Norway spruce. Data are tabulated on growth and stem quality with thinning and fertilizer application. It is concluded that on C_2 sites (fairly fertile and fairly moist), plantations established at low initial density, or appropriately thinnned, grow more vigorously than dense plantations, and can provide pulpwood at 35-40 yr and sawtimber at 60 yr. The application of N fertilizer (2 doses, 100 kg/ha, 15-20 yr before felling), and the sowing of perennial lupin between the rows when the plantation is 2 or 3 yr old, has the effect of reducing the normal rotation by 20-30 yr and producing up to 50 m^3 extra stemwood per ha. Mineral fertilizers have little effect in young plantations. In

plantations established at 1X3 m (3300 trees/ha), one-third of the trees should be cut at 7-8 yr (as Christmas or New Year trees), another third at 20-25 yr for pulpwood, and the rest at 50-60 yr for pulpwood and sawtimber."

Dozsa, J. 1974. (The branchiness of conifers planted at different spacings.) Erdo 23(6): 272-275. (Hu, ru).
From Forestry Abstracts: "An objection commonly raised against the planting of Pinus sylvestris at wide spacings is the possible development of heavy branches. An 11-year-old trial on a sandy site in Hungary showed that the branch sizes were nearly the same at spacings of 1X1 m and 2.5X0.8 m, the only difference being the angle of the branches with the stem (acute at the narrower, and nearly horizontal at the wider spacing)."

Dunsworth, B.G.; Bower, R.C. 1980. A graphic technique for determining spacing and priority. For. Chron. 56(4): 161-162. (En, fr).
From Forestry Abstracts: "Using data from 99 stands of 11 to 16-yr-old Douglas fir in British Columbia, a graph was constructed in which zones of high and low priority for thinning were superimposed on a plot of competitor tree mean stocking (stems/ha) against crop tree mean stocking. A competitor tree was defined as greater than two-thirds the ht. of a crop tree; max. competition ratio was 1:1 and min. 3:1; upper crop and competitor densities were set at 1200 stems/ha; and min. crop tree stocking at 750 stems/ha. The technique could be adapted for other species and is suitable for both manual and computer operation."

Dutrow, G.F. 1971. Economic implications of silage sycamore. USDA, Forest Serv., South. For. Exp. Sta. SO-66. 9 pp.
From Forestry Abstracts: "Reports an exploratory study, by computerized simulation using such estimates as are at present available, of the economic implications of growing Platanus occidentalis at very close spacing on a short coppice rotation, with mechanized harvesting of the wood by silage-handling equipment (cf. FA 32 No. 483). Success appears to depend on substantial expenditure for equipment and the allocation of 4000-8000 acres for such a project. Unless establishement costs can be reduced and a market created, the system would not be economically practicable for non-industrial landowners."

Dyson, W.G. 1974. Experiments on growing Eucalyptus wood fuel in semi-deciduous forest zone in Kenya. East Afr. Agric. and For. J. 39(4): 349-355.
From Forestry Abstracts: "Describes experiments in 1961-72 on growing Eucalypt wood fuel at Muguga (2100 m alt., average annual rainfall 988 mm). A six-year rotation, with regeneration from copice for the second and third rotations, has been adopted to produce 210 m^3/ha (Stacked volume) of billets 10 cm in diam. For use on the EAAFRO Estate. Eucalyptus grandis from New South Wales, Australia, is the most satisfactory and productive species. A hybrid developed in S. Africa and Kenya (E. saligna X E. grandis) is almost as good but gives 6-8% lower yields. The establishment and management of the first (seedling) and subsequent (coppice) rotations are described. Neither the method of felling nor height of stump left significantly affect coppicing ability. Reduction of coppice to 2-3 stems per stump is not advantageous unless there is a local demand for the widths produced. Average yields at six years of age are 178 m^3/ha for the first

rotation and 227 m³/ha for the second and third rotations. A seven-year rotation and closer initial espacement (2.5X2.5 m instead of 3X3 m) are recommended."

Eccher, A. 1973. (Preliminary observations on a young experimental plantation of Pinus radiata in Grosseto province.) Cellul. e Carta 24(4): 41-50. (It, fr, en, de).
From Forestry Abstracts: "Gives data on the growth of a P. radiata plantation at Massa Marittima, Central Italy, established in spring 1965 with seedlings raised from seed of Italian, Spanish and New Zealand origin. Three spacings were used, viz. 1.5x1.5, 2x2 and 3x3 m. Eight years after planting, total stem volume of the stands planted at 1.5x1.5 and 3x3 m was 138 and 68 m³/ha respectively (although mean tree volume at 1.5x1.5 m was only half that at 3x3 m). Conversely, merchantable volume (down to 10 cm diam. o.b.) was slightly higher at 3x3 m (50 m³/ha) than at 1.5x1.5 m (45 m³/ha). Bark % for the less dense of the two stands (1089 trees/ha) was 14-15%, and for the denser stand (4398 trees/ha) 17-18%. The mean annual increment of total stand volume and of merchantable volume, for the whole 8-year-old plantation, was 13 and 12 m³/ha/year respectively. The Italian provenance grew significantly better than the Spanish."

Eccher, A. 1974. (Preliminary results of thinning trials on Pinus pinaster on the island of Elba.) Cellul. e Carta 25(10): 15-27. (It, fr, en, de).
From Forestry Abstracts: "Three thinning treatments, viz. (a) heavy thinning, (b) moderate, selective thinning, and (c) no thinning were applied in 1969 to an 18-year-old P. pinaster stand established on bench terraces near Capoliveri by direct sowing. The mean density of the rather irregular stand before thinning was ca. 1350 stems/ha (range <1000 to >1700), and the plot densities after (a), (b) and (c) were 765, 995 and 1235 stems/ha respectively. An assessment after 5 years indicated that; m.a.i. on the site studied was mainly dependent on the rainfall pattern, but the variability of this pattern made it difficult to determine the right densities for stands at different ages; differences between treatments in growing-stock increment were not significant; and (a) and (b) both had a positive and consistent effect on the volume increment of individual trees, attributable to a greater increase in diameter (but not height)."

Eccher, A. 1975. (Influence of spacing and of selective thinning on the increment of Pinus radiata near Massa Marittima (Grosseto).) Cellul. e Carta 26(718): 45-54. (It, fr, en, de).
From Forestry Abstracts: "Three experimental plots of P. radiata were planted near Massa Marittima in March 1965 at spacings of 1.5x1.5, 2x2 and 3x3 m. Nine years after planting, the plot at 1.5x1.5 m was subjected to a selective thinning of moderate intensity (removal of 40% of the trees, 29% of the b.a., 26% of the volume). P. radiata was found to be capable of reaching, in only 8 years after planting, a mean volume increment o.b. of 17-18 m /ha/year at 1.5x1.5-m spacing at this density, maximum m.a.i. was reached in the 9th year. Ten years after planting, the mean-tree volume in the 3x3-m plot was 2 1/2 times that in the 1.5x1.5-m plot, while the volume per ha in the 1.5x1.5-m plot (179 m³) was ca. 50% greater than that in the 3x3-m plot (121 m³). Of the material removed in thinning (mean d.b.h. 8 cm only), wood down to 3-4 cm d.o.b. was utilized for chipboard. The residual stand was already responding to thinning one year after treatment."

Edwards, P.N.; Grayson, A.J. 1979. Respacing of Sitka spruce. Q.J. For. 73(4): 205-218.
From Forestry Abstracts: "There has been a steady trend towards wider spacing in UK plantations; the Forestry Commission 'normal' spacing has increased from 1.4 m to 2 m over 30 yr. Increased spacing affects revenue production in 3 ways: (a) through reduction in vol.; (b) by increasing tree size at a given age/ht.; and (c) by influencing value per unit vol. through effects on wood quality. Taking account of these points, and results from spacing experiments, spacings of 1.8-2.4 m given the max. net discounted revenue. This is too close to current practice to justify the expense of respacing (non-commercial thinning). It is also suggested that respacing may leave trees with shallower than normal root plates which are more prone to windthrow."

Ek, A.R.; Dawson, D.H. 1976a. Actual and projected growths and yields of Populus 'Tristis 1' under intensive culture. Can. J. For. Res. 6(2): 132-144. (En, fr).
From Forestry Abstracts: "The growth of P. 'Tristis No. 1' was studied for 4 years in plots established from cuttings spaced at 0.75x0.75, 1x1, and 2x2 ft on a prepared site in Wisconsin. The results were used to derive expressions for ht. and diam. growth; for the relations between competition, realized growth and potential growth (competition index); and for the relation between competitive status and the probability of survival. From these expressions, growth and yield were projected using the FOREST model (see FA 36, 7938). Stand development was projected for periods of up to 25 yr for the original spacings and for 4-, 8-, and 12.7-ft spacings, obtained by assigning new coordinates to the data. Actual and projected stand development showed close agreement. The limitations of the projections are discussed. The projected yield for the 4-ft spacing is about 5.8 times that possible from natural aspen stands."

Ek, A.R.; Dawson, D.H. 1976b. Yields of intensively grown Populus: actual and projected. Pages 5-9 in Intensive plantation culture - five years research. USDA, For. Serv., North Cent. For. Exp. Sta. Gen Tech. Rep. NC-21.
From Forestry Abstracts: "Growth data were obtained from P. 'Tristis No. 1' grown in a nursery in Wisconsin under 3 spacing regimes (0.75, 1 and 2 ft). A computer simulation program (FOREST) used the data to project performance of these and 3 wider spacings up to 25 yr. Over the range of spacings examined (0.75 to 12.7 ft), av. annual growth peaked at 8 to 15 yr with stem and branch wood dry wt. in the range 13 881 to 16 584 lb/acre p.a."

Elfving, B. 1975. (Volume and structure in unthinned stands of Scots pine.) Rapp. och Uppsatser, Inst. Skogsproduk. No. 35, 128 pp. (Sv, en).
From Forestry Abstracts: "Presents an analysis of the structure of unthinned natural and planted stands of Pinus sylvestris 12-260 years old in Sweden in relation to b.a., diameter, height, age, number of stems, etc. and develops a model to describe volume and structure. Special consideration is given to the development up to 22 years old of P. sylvestris in an unthinned spacing trial (initial spacings 0.75-3.0 m) in relation to natural thinning, height, diameter and branch development and the development of single trees. The use of the difference between top height and mean height as a measure of stand evenness, and of functions to describe

diameter distributions and the relation between mean diameter, mean height and stem number per ha, is explained."

Elgueta Salinas, H.; Calderon Sanchez, S. 1971. (Study of Prosopis tamarugo as a source of fodder for sheep in the Pampa del Tamaruga, Chile.) Chile, Inf. tec. Inst. For. No. 38. 36 pp. (Es, en).
From Forestry Abstracts: "Studies were made from 1967 to 1969 on 30 plots in existing plantations of P. tamarugo of known age. Information is given on the production of foliage and fruit as a function of age, initial spacing and environmental conditions. Growth is related to age and initial spacing, and productivity to age. Salinity of the ground water was not significant. An initial spacing of 13.5x13.5 m seems to be the most profitable."

Endean, F.; Jones, B.E. 1972. Clean cultivation and the establishment of Pinus keysiya in Zambia. East Afr. Agric. For. J. 38(2): 120-129.
From Forestry Abstracts: "Reports a split-plot factorial experiment, on two soil types, to compare four methods of site preparation (complete ploughing + disking, line ploughing + disking, disking, and spot cultivation), in combination with four intensities of subsequent cultivation (disking four times, disking twice, disking once, and spot cultivation) during the first year after planting. Planting was done in Nov. 1965 with tubed stock at 9x9-ft spacing. Data are given for survival %, height growth, weed growth and soil moisture over a 14-month period. Survival (24-92%) and height growth (1.3-2.5 ft) were directly correlated with the intensity of cultivation. Site preparation had no effect on any of the variables measured and did not interact with the weeding treatments. Intensive weeding (disking four times) has now been adopted as standard practice in pine plantations in the first year."

Enghardt, H.G.; Mann, W.F., Jr. 1972. Ten-year growth of planted slash pine after early thinnings. USDA, Forest Serv., Southern For. Exp. Sta. Res. Pap. SO-82. 11 p.
From Forestry Abstracts: "Eight different thinning treatments were applied to sample plots in a 17-year-old plantation of Pinus elliottii var. elliottii (original spacing 6x7 ft) in central Louisiana in 1958 (cf. FA 34, 2864). Data are tabulated for intermediate yield, volume p.a.i. from 17 to 27 years, and the diameter distribution at 27 years of age."

Eriksson, L. 1977. (Stimulation of stand development after cleaning.) Rapp. och Uppsater, Inst. för Skogsteknik. No. 108, xi+7 pp. Sv.
From Forestry Abstracts: "The second report of a study on the effects of mechanized cleaning (precommercial thinning) on the development of Scots pine and Norway spruce stands in Sweden. Using the increment models of the first report (see FA 41, 763), development was simulated in 4 stands (density 4000-10 866 stems/ha) for the first 10-yr period after cleaning. The treatments compared were selective thinning, strip thinning (strip widths 2, 2.5, 3 and 4 m) and combined strip and selective thinning; the number of remaining trees varied from 800 to 6000 stems/ha. The main results are presented in graphs, and the results obtained by the simulation are compared with data from strip thinning experiments established at Lycksele and Långshyttan, central Sweden, in 1970-72."

Erken, T. 1972. (Afforestation of abandoned fields.) Sver. Skogsvårdsforb. Tidskr. 70(5): 467-476. (Sv, en).
From Forestry Abstracts: "Discusses chiefly the relative merits of Birch (Betula verrucosa) and Norway Spruce for afforestation of abandoned agricultural land in Sweden; the area of such land is expected to reach a total of ca. 700 000 ha for the period 1966-1980, though much of this may be in units too small for economic afforestation. Assessments for Birch (26 years old) and Spruce (25 years old) planted at 1.5x1.5-m spacing on trial plots in the same locality suggest that Spruce is likely to produce more merchantable timber than Birch, but about the same amount of dry matter annually. Economically, calculation of gross margins favours Spruce but, because of the faster growth of Birch, soil value calculated with 1971/1972 prices and costs would be higher for Birch if the interest rate used is ≥5%."

Erteld, W. 1975. (Spacing, annual ring width and branch thickness in Pinus sylvestris is an average site on the lower Pleistocene of E. Germany.) Soz. Forstwirt. 25(8): 242-245. (De).
From Forestry Abstracts: "The relation between (a) mean ring width (estimated from diameter measurements corrected for bark) and (b) the basal diameter of the larger branches at 0.5-4.0 m above the ground was studied in four stands, ca. 25 years old, on an average sandy site. The stands were planted at spacings of 1x1, 1.4x0.5 or 1.2x0.5 m, or from dense natural regeneration respectively. Further data on ring widths were obtained from increment-core samples at stump height. The coefficient of regression of (b) on (a) and the correlation coefficient increased with increasing height up the stem. The lowest density of 1x1 m yielded stems that were just within the quality limit as judged by the size of branches to be removed in pruning, and by the mean ring width in the juvenile core at stump height. At densities of 1.2x0.5 m or above, no pruning would be needed."

Escobar, R.R.; Espinosa, B.M.; Medina, V.G.; Quesada, J.L. 1976. (Determination of the required size of forest nurseries.) Chile For. 1(12) (Supl. 8). 4 pp. (Es).
From Forestry Abstracts: "Gives tables and formulae for calculating the size of nurseries required to produce sufficient 1+0, 2+0, 1+1 or 1+2 planting stock for plantations at various spacings from 2.5x2.5 to 2.0x1.0 m (requiring 1600 to 5000 plants/ha), with examples of their use."

Evans, J. 1976. The influence of spacing in a pulpwood plantation. South Afr. For. J. 46: 23-26.
From Forestry Abstracts: "A note on some of the effects of close spacing observed in pulpwood plantations of Pinus patula owned by the Usutu Pulpwood Company in Swaziland. The stands were left unthinned throughout the rotation at their initial planting density, which varied from ca. 500 to ca. 770 trees per acre. Nine years after planting, the more closely spaced plantations had a significantly higher total volume per acre, but average tree size was less, and reasons are given for concluding that in such plantations management and logging costs are likely to outweigh the advantage of higher volume yield."

Evert, F. 1971. Spacing studies: a review. Can. For. Serv., For. Manage. Inst. Inf. Rep. FMR-X-37. ix+95 pp. (En, fr).

From Forestry Abstracts: "A critical study, describing and briefly evaluating past and present spacing practices and studies in some countries that have large-scale planting programmes. Though such studies have confirmed that initial spacing affects various tree and stand characteristics, they have yielded few conclusive results for assessing the 'differences in degree' that would allow decision-making, mainly because of limitations in the definition of aims, the statistical design of the experiments, and the length of time needed to carry experiments to their final conclusion. To overcome these limitations, the author recommends that such studies should include the preparation of growth models for individual trees as well as stands, and proposes two suitable lay-outs--a factorial experiment, or a lay-out involving a number of plots at each of the different spacings in existing plantations. A brief review of Canadian spacing studies is presented."

Evert, F. 1973. Annotated bibliography on initial tree spacing. Canada, Forest Mgmt. Inst. Inf. Rep. FMR-X-50. 149 pp. (En, fr).
From Forestry Abstracts: "The bibliography covers the literature for the period 1920-1971, and has a general section (82 references) and a list by species (including tropical species). Annotations or an abstract (many of them taken from Forestry Abstracts are given with each reference, and author, species and subject indexes are provided."

Faber, P.J. 1971. (Stand density and development of young pine stands.) Ned Bosb. Tijdschr. 43(5): 91-104. (Nl, en).
From Forestry Abstracts: "Gives results of investigations on initial density and pre-commercial thinning trials in Corsican Pine stands in Holland. The results are evaluated in terms of the productivity indexes RGB and RVB respectively the b.a. and the volume increment per ha, per unit increase in dominant height) and predictions of stand development. It is concluded that an initial density of >5000 or <4000 plants/ha cannot be recommended, and also that it is neither feasible nor necessary to avoid pre-commercial thinnings entirely."

Faber, P.J. 1977. (A growing space study with Populus 'Dorskamp' in East Flevoland.) Populier, 14(2): 31-38. (Nl, en).
From Forestry Abstracts: "An experiment was established in 1968, with 1-yr rooted cuttings at various spacings from 4x4 to 8x8 m. An assessment was made at age 9; at this time only the earliest of the planned thinnings had been made, on the densest plots. The effect of spacing on ht. growth was small (mean ht. ranged from 14.57 to 15.30 m) but ht./diam. ratios varied from 77 to 59 from the closest to the widest spacing. There were indications that vitality (in terms of b.a. or vol. increment per m of ht. increment) falls off when ht. is about 3 times spacing."

Faber, P.J. 1978. (When should narrowly spaced poplar plantations be thinned?) Populier 15(3): 55-60. (Nl, en).
From Forestry Abstracts: "Growth and yield data are presented for a trial in which plantations of Populus 'Oxford' and P. 'Robusta' established at 4x4 m spacing were thinned for the first time at ages ranging from 8 to 17 yr, removing 50% of stem numbers, and again, removing 50% of the remaining stems, 4 yr later. At ages 18 or 19 respectively, vol. yield was 40% greater for late than for early thinned plots, at the expense of stand stability. The first thinning reduced vol. c.a.i. by 30% and the second

reduced it by 50% vs. unthinned. Growth reductions were greater after earlier treatments. It is suggested that, for the production of large timber, the first thinning should take place at a mean height of 15 m (age 12-14); for small timber (d.b.h. 25 cm), the greatest vol. yield is obtained without thinning."

Fakirov, V. 1972a. (Growth and yield of hybrid black poplar plantations planted at various initial densities in Danube flood-plain sites.) Gorskostop. Nauka. 9(1): 37-52. (Bg, ru, de).
From Forestry Abstracts: "Plantations of five different clones were established at initial spacings of 3x3 to 8x8 m on sites 2 m above the mean level of the Danube, i.e. on sites between Willow/Poplar and typical Poplar sites. Observations for the first 7 years (1962-68) indicated that none of the clones was particularly resistant to prolonged flooding. Populus 'I-214' was the best as regards growth, and the closer spacings were preferable in all the clones tested."

Fakirov, V. 1972b. (Growth and yield of hybrid black poplar plantations planted at various initial densities on drained sites near the Danube.) Gorskostop. Nauka. 9(2): 3-20. (Bg, ru, de).
From Forestry Abstracts: "Plantations of five different clones were established at initial spacings of 3x3 to 8x8 m on sites where the depth of the water table in April-July averaged 1 m. Data on performance for the first 7 years (1962-68) indicated little difference between the clones. Populus 'I-214' was the best as regards growth, and a spacing of 4x4 m appeared to be the most suitable."

Fakirov, V. 1976a. (Effect of growing space on mean height in poplar plantations.) Gorskostop. Nauka 13(4): 51-63. (Bg, ru, de).
From Forestry Abstracts: "Gives results of height measurements in spacing trials in plantations in Bulgaria of Populus 'Regenerata', P. 'I-214', and P. 'Vernirubens' at 14 years, at spacings of 3x3, 4x4, 6x6 and 8x8 m, and also on P. 'Regenerata' at 4, 10, 13 and 20 years at closer spacings, viz. 1.5x1.5, 2.0x2.0, 2.0x2.5, and 2.5x2.5 m. In youth, the dense plantations have the greatest mean height growth, but with increasing age it is greater in the more open plantations. It is concluded that mean stand height cannot be used to characterize site conditions because of the differing patterns of height growth depending on initial density. After the start of differentiation of trees within the plantation, height should be measured only in trees of growth class I, and yield tables should be constructed on the basis of the height of such trees."

Fakirov, V. 1976b. (Effect of the growing area on the yield of hybrid black poplars.) Gorskostop. Nauka 13(1): 22-33. (Bg, ru, de).
From Forestry Abstracts: "Gives results of studies in Bulgaria on a typical Poplar site (flood-plain) and on a drained site, with Populus 'Regenerata', P. 'I-214' and P. 'Vernirubens' grown at various spacings ranging from 2x2 to 10x10 m. Data are presented on the b.a. of the various clones up to 14 years. The closest spacings gave the maximum wood production; the optimum spacing, however, depends on the eventual use of the wood, e.g. for pulp and particle-board manufacture, maximum yield is obtained with spacings of 2x2 or 3x3 m, and felling at the age of quantitative maturity, without thinning. In general, spacing should be closer on the better

sites. Differences in yield between the various spacings were greater on the better sites."

Fakirov, V. 1980. (The amount of foliage in unthinned and thinned poplar plantations.) Gorkostop. Nauka 17(3): 3-18. (Bg, ru, de).
From Forestry Abstracts: "Investigations are reported on the amount of foliage in plantations of Populus 'Regenerata' aged 7, 13, 16 and 22 yr, initially established as a spacing of 2x2 m near the Danube in Bulgaria. The measurements were made 3 yr after a thinning removing 40-45% by vol. on some of the plots. The amount of foliage (in m^2 and kg) is shown in relation to tree age, diam., ht., and increment, for tree (crown) classes I, II, III and IV. The age of max. foliage formation (8-10 yr) coincided with the age of the max. amount of fine roots and with the culmination of b.a. increment and leaf index, and also with the start of differentiation of tree classes. Accordingly, thinnings in such plantations should not start before age 8-10 yr."

Feduccia, D.P.; Mann, W.F., Jr. 1976. Bark thickness of 15-year-old loblolly pine planted at different spacings. USDA, Forest Serv., Southern For. Exp. Sta. Res. Note SO-210. 2 pp.
From Forestry Abstracts: "Data collected during the first thinning of Pinus taeda planted at 5 initial spacings on plots with site indices of 77-111 ft, in SW Louisiana, showed that d.b.h. was the only variable affecting bark thickness at b.h. and at the midpoint of the merchantable stem. Bark thickness at the 4-inch top was not correlated with d.b.h."

Ferrari, G.; Scaramuzzi, G. 1979. Effects of tree spacing on wood density in Eucalyptus globulus and E. x trabutii. In technical consultation on fast-growing plantation broadleaved trees for mediterranean and temperate zones, Lisbon, Portugal, October 1979. (FAO Report) Vol. 2: 225-235. (En, en, fr, es).

Fishwick, R.W. 1976. (Spacing and thinning studies in Brazilian plantations.) Bras. Florestal 7(26): 7-9, 13-23. (Pt).
From Forestry Abstracts: "Trends in the initial spacings used for softwood plantations in the UK, S. Africa and New Zealand during the last 40-50 years are compared with those characteristic of forestry in Brazil (where the initial spacing of 1x1 m for Araucaria angustifolia has been increased to at least 2x2 m and the spacings for Pinus spp. have been increased from 1.5x1.5 m to 2.5x2.5 m). The silvicultural and economic reasons for these trends are considered, and the various effects of spacing on trees and stands are discussed, especially the effects on wood quality and the volume of merchantable timber produced. The spacing and thinning practices adopted in Brazil are examined in some detail with particular reference to Pinus spp., and fields for further research are identified."

Fishwick, R.W. 1976. (Influence of intial espacement and thinning practices on the form of trees in plantations of Pinus elliottii) FAO Rep. No. PNUD/FAO/IBDF/BRA-45, Comunicacao Técnica 2, 9 p. (Pt).
From Forestry Abstracts: "Preliminary results of a study of stands of P. elliottii planted at 1.5x1.5, 2x2, 2.5+2.5 and 2.8x2.8 m spacing at two sites in southern Brazil. When examined three years after planting, the stands had neither been thinned nor pruned. For each site and spacing, data on survival %, the number of dominant, co-dominant, sub-dominant and

suppressed stems, and the number of defect-free dominant and co-dominant stems are tabulated and discussed. The results suggest that to provide a final crop of 200-250 trees/ha (after the third thinning), stands should contain ca. 400 stems of good form after the first thinning. which may be selective or partly mechanical; from these stems final selection will be made. The merits of each spacing as a means of obtaining the required number of trees of good form are considered."

Flöhr, W. 1975. (Choice of spacing in P. sylvestris plantations from the silvicultural and technological viewpoint.) Soz. Forstwirt. 25(8). (De).

Fonseca, J.M.M.A.; Aguiar, I.B.; Fernandes, P.D. 1974. (The silvicultural behaviour of native Brazilian and exotic species in arboretum conditions. (1).) Cientifica 2(2): 198-207. (Pt, en).
From Forestry Abstracts: "Presents data on survival, total height and diameter, and m.a.i. (height and diameter) at 4 years of age, for 16 native species and exotics planted in small plots (63 plants per species, spacing 2.8x2 m) in an arboretum on red latosol at Jaboticabal, in S. Brazil. Melia azedarach has done best. Acacia decurrens grew well but suffered from pests and diseases. Cunninghamia lanceolata was the only exotic considered unsuitable (height m.a.i. <1 m). The best native species were Piptadenia spp. and Cetrolobium robustum."

Francis, J.K. 1977. Fertilizer and mulch improves yellow-poplar growth on exposed Hartsell subsoils. USDA, Forest Serv., Southern For. Exp. Sta. Res. Note SO-231. 3 pp.
From Forestry Abstracts: "On a forest site in the Cumberland plateau, Tennessee, Liriodendron tulipifera seedlings were planted on 12x12-ft plots (9 trees/plot) that were (a) undisturbed, (b) artificially eroded by removing the organic and A horizons, and (c) as (b) but with the litter layer replaced as a mulch. After one growing season, half of the plots were fertilized with 2 tons/ acre dolomite limestone, 150 lb/acre N as NH_4NO_3 and 100 lb/acre P as triple superphosphate. Data are given on ht. growth, ht. and root-collar diam. increments and root wt. up to 4 yr old. In unfertilized plots after the first year, ht. growth in (c) equalled that in (a) and was significantly better than in (b). Fertilizing increased increment markedly in the first year in all treatments, but had no subsequent effect except in (b). It is concluded that poor growth on exposed subsoil is not due to soil physical properties (in this soil type), and that fertilizing will result in normal establishment."

Freitas, E.R. De; Ferreina, M.; Borges, C.P. 1972. (Studies of botanical variations in stands of Eucalyptus alba, E. saligna, E. grandis and E. propinqua.) IPEF No. 4: 117-134. (pt, en).
From Forestry Abstracts: "Studies were made on a total of 233 trees in trial plantations at Itepuva and Mogi Guaçu, São Paulo, to determine: the influence of spacing in flowering at 5 years of age; variations in the morphology of leaves, buds and fruits within each species; and variations in the mean basic density at b.h. The trees were classed into three morphological types, viz. typical, commercial and atypical, and the % of each type in the two areas was estimated. It was established, that: although there were interspecific differences, spacing did not influence flowering in either locality; flowering of E. grandis and E. propinqua was similar in both localities, but E. alba and E. saligna flowered more

abundantly at Mogi Guaçu; mean basic density of the wood at Itepuva was highest in E. alba and E. propinqua, and at Mogi Guaçu it was highest in E. propinqua; there seemed to be no outstanding differences in mean basic density between the three types distinguished. It is concluded that: the present methods of producing and collecting seed are inadequate, and the establishment of seed orchards kept under controlled conditions is necessary for the production of certified seed; selective breeding programmes should be implemented in the specific regions where the seed is destined for use; E. propinqua is the only species suitable for the selection of phenotypes in commercial plantations; and plantations of E. alba, E. saligna and E. grandis for commercial purposes combined with seed production should be established with certified Australian seed."

Frison, G. 1974. (Poplar plantations with a two-year rotation.) Cellul. Carta 25(9): 10-21. (It, fr, en, de).
From Forestry Abstracts: "Reports the results of nursery experiments on Populus 'I-214' to determine the total biomass production (stemwood, branchwood and bark) of (a) one-year-old rooted cuttings ('barbatelle') grown at 130x9-cm spacing and cut back annually one or more times, and (b) two-year-old saplings derived from cuttings or cut-back 'barbatelle', planted at 155x55 or 155x60 cm. Total biomass produced annually by (a) was 30 000 kg/ha, while that produced biennially by (b) was 60 000 kg/ha; (b) actually produced more useful material than (a) as the % of bark was lower (20% vs. 30%). The results show clearly that high yields of pulpwood can be obtained from selected Poplar clones grown on very short rotations at close spacings on good sites."

Frison, G. 1976. (Effect of mineral fertilizers on the growth of poplar.) Cellul. Carta. 27(5): 3-20. (It, fr, en, de).
From Forestry Abstracts: "Describes a long-term experiment to determine the effect of NP and PK fertilizers on the growth of a Poplar plantation established in 1969 on land near Mantua previously used for agriculture and rather poor in nutrients. The species used was Populus 'I-214', at an initial spacing of 6x5 m. Applications of NP or NPK were made in 1970, 1972 and 1974 at rates of 160, 200 and 300 kg/ha of N_2, P_2O_5 and K_2O respectively. Analyses of variance show that the fertilizers had highly significant effects on b.a. increment in the years of application but no residual effect in the succeeding years except in the year following the first application. Incorporation of K in the fertilizer gave results significantly better than those obtained with NP for the first application only. Despite some anomalies in particular years, it appears that, under the conditons studied, the cumulative effects of using mineral fertilizer on both b.a. and height increment are significant, but the profitability of the treatment cannot be assessed until the trees are felled."

Frison, G. 1979. (Double entry volume and freshweight tables for coppiced poplar stands.) Cellul. Carta 30(10): 3-28. (It, fr, en, de).
From Forestry Abstracts: "Data for compiling the tables were collected in three coppiced stands of Populus 'I-214' established at 2x2, 2x2 and 3x2 m spacing and aged 3, 4 and 6 yr, respectively. In the tables the vol. of timber o.b. of the whole stem including branches and of the stem topped at 4 cm diam. is expressed as a function of d.b.h. and of total tree ht; the vol. of stem wood down to 4 and 7 cm diam. is expressed as a function of d.b.h. and of ht. to 4 and 7 cm stem diam. respectively. Tables giving

fresh wt. for stems of a given d.b.h. and ht. were similarly compiled. From author's summary."

Frison, G. 1980. (Research on volume and growth of Populus 'I-214' grown at 3x2.50 m spacing.) Cellul. Carta 31(10): 3-32. (It, fr, en, de).
From Forestry Abstracts: "Data were collected on the volume and fresh weight of 51 sample trees in a 6-yr-old stand. Calculations were made of total vol. (stem and branchwood, including bark) and vol. of stems down to 4, 7 and 10 cm top diam. Double-entry volume and weight tables compiled from the data are presented. They show (a) vol. and wt. of stem wood with and without branches (bark included), and of stems down to 4 cm top diam., expressed as a function of d.b.h. and of total ht., and (b) vol. and wt. of stem wood down to 4, 7 and 10 cm top diam., expressed as a function of d.b.h. and of ht. corresponding to 4, 7 and 10 cm top diam."

Fromsdorf, U.; Magnussen, S. 1980. (The European larch spacing experiment in the Karlshafen Forest Administration, Hesse.) Forstarchiv 51(6): 113-118. (De, en).
From Forestry Abstracts: "A reassessment was made in 1979 of a spacing trial of larch (Larix decidua) established in 1952 with spacings of (a) 1x1, (b) 2x2 and (c) 3x3 m. The stands were thinned in 1971 (with pruning of selected stems) and in 1977, leaving (a) 1200, (b) 1100 and (c) 700 stems/ha. In 1979 the d.b.h. of the b.a. mean stem was (a) 15.1, (b) 16.5 and (c) 21.4 cm, crown length and diam. being significantly greater in (c). B.a. and standing vol. per ha increased with increasing spacing owing to lighter thinning. The development of the beech understorey was satisfactory in (b) and (c) but not in (a). Because the heavy thinning in (a) was uneconomic and too few straight clear stems were produced in (c), a 2x2-m spacing (already widely used) is recommended to produce the desired 250-300 good-quality stems/ha at age 30 yr."

Gallagher, G.J.; O'Brien, D.; Lynch, T.J. 1980. Silvicultural and economic aspects of spacing and thinning in Sitka spruce and lodgepole pine. Univ. Göttingen/Niedersächs. Forstl. Versuchsaust., Forstl. Fakult., Schriften 67: 193-205. (En, de, fr).

Ganchev, A.; Ganchev, P. 1971. (Growth and yield of some poplars in the Yambol collection.) Gorsko Stopanstvo, 27(7): 26-30. (Bg).
From Forestry Abstracts: "Gives details of the growth of 11 different poplar clones and hybrids at age 11 years in plantations at spacings of 3x3, 4x4, 5x5, and 6x6 m in Bulgaria. Populus 'I-214' was clearly the best followed by P. 'Vernirubens', and P. 'Canadensis B-50'."

Garavel, L. 1972. (A new possibility: the production of walnut timber.) France, Off. Nat. For., Bull. Tech. No. 3: 5-8. (Fr).
From Forestry Abstracts: "It is recommended that Walnut should be planted for timber. Nuts of Juglans nigra that may have been pollinated by J. regia are sown in the nursery, and the hybrids selected during the first growing season. Planting should be at 11x11 m, using 2+1, 1+2 or 1+3 transplants. Pruning should be done to a height of 4-4.5 m. The aim is to produce peeler logs of more than 160 cm girth; it is predicted that the hybrid will grow to 225 cm in 75 years."

Garcia C., J.R. 1973. (Application of intermediate fellings in plots of Tectona grandis in Araure-Acarigua, Venezuela.) Rev. For. Venez. 16(23): 67-82. (Es).
From Forestry Abstracts: "Since 1969 the effects of thinning from above (based on the Hart/Becking spacing factor) have been studied in blocks in two stands planted in 1963 and 1964 respectively, derived from seeds from Trinidad. The 9 experimental plots differed in original spacing (2x2 or 3x3 m) and in frequency of thinning. Data on the mean annual increments in height, b.a. and volume o.b. are tabulated."

Gardiner, J.J.; O'Sullivan, P. 1978. The effect of wide espacement on wood density in Sitka spruce (Picea sitchensis. (Bong.) Carr). Irish For. 35(1): 45-51.
From Forestry Abstracts: "Wood density was measured from cores taken at various heights on the tree in 2 stands in Co. Leitrim, Ireland, that had been planted at 2.4x2.4 m and 4.5x4.5 m and in both cases consistently pruned to leave 2/3 of the green crown. The results showed that a good estimate of the average wood density of a single tree could be obtained from one boring at b.h. and an appropriate factor, and that samples from 7 trees would give a good estimate of the mean wood density of the stand. The wood density of the more widely spaced stand was less than that of the other, at all points of measurement. There were indications that green pruning evened out within-tree variation in wood density such as occurs at wide spacing without pruning."

Garia, S., J.; Prado D., J.A. 1978. (Effect of spacing on the development of Pinus radiata at Antiquina (Arauco Province).) Inst. For., Inf. Técn. No. 61. 31 p. (Es, en).
From Forestry Abstracts: "Preliminary results from spacing trials at 16 yr are presented, including details of planting density, diam. class, b.a./ha and vol. growth. Four spacing distances were used, ranging from 1x1 m to 3x3 m. Early thinning was necessary in the densest stand and pruning was required in the stands with widest spacing. The utilization index chosen for sawlog volume affects the judgement of which spacing gives best sawlog output. A 2 mx2 m spacing is recommended as the most flexible, to be used where the eventual use of the wood is not determined in advance."

Gathy, P. 1975. (Corsican pine in the belt south of the Meuse.) Bull. Soc. R. For. Belg. 82(2): 117-119. (Fr).
From Forestry Abstracts: "Gives comparative data on the growth of Pinus sylvestris, P. nigra s.s., P. nigra var. maritima and Picea abies in this part of Belgium, and concludes that of these four softwoods P. n. var. maritima should be preferred for planting (at 1.50x1.50-m spacing) on account of its superior growth and suitability for the climate and for the most degraded hardwood sites."

George, E.J.; Frank, A.B. 1973. Graded nursery stock in shelterbelt type planting evaluated over 29-year span. Tree Planters' Notes 24(1): 30-32.
From Forestry Abstracts: "In 1941, twelve seedlings each of four diameter-grades of Fraxinus pennsylvanica and three grades of Ulmus americana were planted at 4x10-ft spacing in separate rows in a sandy loam soil with low water-holding capacity at Mandan, N. Dakota. F. pennsylvanica grades 1, 2, 3 and 4 averaged 2.9, 1.8, 1.5 and 0.8 ft in height and 0.52, 0.33, 0.22 and 0.15 inches in diameter respectively, and U. americana grades 1, 2, and

3 averaged 2.6, 1.4, and 1.1 ft in height and 0.42, 0.24 and 1.9 inches in diameter respectively, at planting. Data on height and diameter from 1941 to 1969 show that after 29 years grades 1 and 2 of F. pennsylvanica were superior to grades 3 and 4. Height growth of grades 1 and 2 of U. americana was superior to that of grade 3, but diameter growth of grade 1 was inferior to that of grades 2 and 3."

Geyer, W.A. 1978. Spacing and cutting cycle influence on short rotation silver maple yield. Tree Planters' Notes 29(1): 5-7, 26.
From Forestry Abstracts: "Silver maple (Acer saccharinum), one of many fast growing coppicing species, has great potential, from producing fibre rapidly to use as fuel or fodder. The results of field studies on alluvial soil in Kansas are reported, showing that trees grown at close spacings produced annual DM yields of 4 tons/acre, even after numerous cuttings over an 8-yr period. Annual yields were higher with a longer cutting cycle. The density, m.c. and fuel value of silver maple silage are discussed."

Geyer, W.A. 1981. Growth, yield and woody biomass characteristics of seven short-rotation hardwoods. Wood Sci. 13(4): 209-215.
From Forestry Abstracts: "Seedlings were grown for 2 yr followed by coppicing for 2 yr on bottomland sites in Kansas, using 6 species: (a) Populus deltoides from 2 different sources (Missouri and Nebraska); (b) Acer saccharinum; (c) Platanus occidentalis; (d) Salix exigua; (e) Acer negundo; and (f) Alnus glutinosa. The best growth, wt. yield and coppicing characteristics were obtained from (a) and (b). The 4-yr total oven-dry yield ranged from 5.2 t/ha for (f) at a spacing of 1.2x1.2 m to 28.2 t/ha for (a) from Nebraska at a spacing of 0.3x1.2 m. Closer spacing, and silty, as opposed to sandy, soil produced highest yields. The greatest effect of spacing was on individual tree characteristics. Coppice yields were about 62% greater than seedling yields. Av. whole-tree density (including bark, buds etc.) was generally slightly lower than values in the literature. Bark accounted for about 21% of the oven dry wt. of 2-yr-old coppice shoots. Volumetric heat value varied from 14.35x10^3 kcal/m^3 for (a) from Missouri to 19.29x10^3 kcal/m^3 for (c)."

Gibson, G.E.; Sossaman, E.C. 1977. Fifteen-year results on a sweetgum spacing study. Tree Planters' Notes, 28(1): 18-20.
From Forestry Abstracts: "Seedling of Liquidambar styraciflua were planted at spacings of (a) 5x5, (b) 7x7 or (c) 9x9 ft on an abandoned floodplain pasture in Alabama. After 15 yr, total vol./acre was greatest in (b); vol./tree was greatest in (c). 7x7 ft spacings are recommended for short rotations and total-tree harvesting techniques; 9x9 ft spacings are suitable for lumber production with conventional harvesting techniques."

Gilliland, J. 1980. A re-appraisal of Irish silvicultural practices. Ir. For. 37(2): 107-111.
From Forestry Abstracts: "Arguments are presented in favour of using the short-rotation 'oceanic system' for the growing of Sitka spruce in Ireland where resistance to windthrow is paramount, viz. planting at 2000-2500 stems/ha with respacing at 5-9 yr old to give a final spacing of 700-800 stems/ha. Unwanted stems are pollarded at respacing to avoid problems with Fomes annosus (Heterobasidion annosum)."

Gilmore, A.R. 1978. Effects of past applications of limestone on height growth of shortleaf pine and loblolly pine. Univ. Ill., Dep. For., For. Res. Rep. 78-9. 2 pp.
From Forestry Abstracts: "Results are presented 12 yr after planting (in 1964) of 1+0 stock of (a) Pinus echinata and (b) P. taeda (1.8x2.0 m spacing) on experimental plots in S. Illinois. Av. ht. of (a) was 5.7 m on unlimed plots, 5.2 m on limed plots; av. ht. of (b) was 8.1 m on unlimed plots, 7.6 m on limed plots. It is concluded that root growth may have been restricted in limed plots."

Gilmore, A.R.; Gregory, R.P. 1974. Twenty years growth of loblolly and shortleaf pine planted at various spacings in southern Illinois. Ill. State Acad. Sc., Trans. 67(1): 38-46.
From Forestry Abstracts: "Pinus taeda and P. echinata were planted at four spacings (from 4x4 to 10x10 ft) and measured at ages 11, 13, 18 and 20 years. Mensurational data are given showing how the stands developed. At 20 years of age P. taeda showed better growth than P. echinata, P. taeda gave its best volume at 8x8 ft spacing, and P. echinata at 6x6 ft. Increment has apparently not culminated yet, and a rotation of 20 years would be too short."

Giordano, E.; Avanzo, E. 1979. (Effect of thinnings in a dense plantation of Populus 'I-214'.) Montanaro d'Italia-Monti e Boschi 30(2): 75-78. (It, en).
From Forestry Abstracts: "Results are given of an experiment in managing a plantation near Rome planted in 1962 with 50-cm cuttings at 1.5x1.5 m spacings. After 3 yr a first mechanical thinning was made, increasing the spacing to 3x3 m and removing 755 of the standing vol. (126 out of 168 m^3). After another 3 yr, when the standing crop was 165 m^3/ha, a second mechanical thinning was made, increasing the spacing to 6x6 m. At the end of the 13th year the final crop was 229 m^3/ha, less than the vol. from the intermediate yields (250 m^3/ha). Data are given on the variations in rate of increment during the life of the plantation. Although the close planting had some beneficial effect on stem quality by encouraging self-pruning of the trees, it is concluded that it is better to establish plantations at a definitive spacing chosen to fit the rotation in view and the timber assortments required, rather than to plant close and resort to thinnings."

Gizatullin, S. Kh. 1973. (Survival and growth of young oak stands of different density in the south of the Odessa region.) Lesn. ZH. 16(2): 25-29. (Ru).
From Forestry Abstracts: "Compares Quercus robur plantations aged 13-14 years, established on dark-chestnut soils or on southern chernozems by sowing or planting at initial densities from 4760 to 60 550 plants/ha, of which the Oak accounted for 2380 to 55 100 plants/ha. No tending fellings had been done. Data on natural mortality, survival and growth are interpreted as favouring establishment at the lower densities."

Godman, R.M.; Cooley, J.H. 1970. Effect of initial spacing on jack pine growth and yield. Mich. Acad. 2(4): 107-111.
From Forestry Abstracts: "An evaluation was made 22 years after planting, of stands established in Michigan in 1941 at spacings of 1 1/2x1 1/2, 3x3, 5x5, 7x7, and 9x9 ft. Results suggest that branch size at 22 years is a

good indication of branch size at rotation age. Branches were not much larger on trees planted at 9x9 ft than on those planted at 5x5 or 7x7 ft. Accordingly, contrary to earlier conclusions, spacing at 9x9 ft could be the most profitable, especially for pulpwood production."

Gomis, H.D. 1973. (Establishment of a plantation of Pinus contorta var. latifolia in the southern Cordillera of Rio Negro, Argentina.) Rev. For. Argent. 17(4): 107-108. (Es).
From Forestry Abstracts: "Describes a plantation established in 1968 with 1+2 stock at a spacing of 2x2 m, on a degraded, over-grazed, scrub- invaded site, and gives details of increment up to 1973. The Pine has grown well, height increment in 1973 being ca. 1 m and total height $2^1/_2$-$3^1/_2$ m, though some forking is evident."

Gomis, H. 1974. (Establishment of a plantation of Pseudotsuga menziesii var. viridis in the southern Cordillera of Rio Negro territory, Argentina.) Rev. For. Argent. 18(3): 73-75. (Es).
From Forestry Abstracts: "Gives details of the establishment of a plantation of ca. 16 ha on a steep slope at 750 m alt., formerly occupied by dense broadleaved scrub with Nothogafus antarctica predominant. The plants used were 1+2 bare-rooted stock, planted at 2x2 m in June-Sept. 1972. Details are given of survival and growth in 1973 and 1974. In general the plantation appears promising."

Goo, M. 1971. (Relationship of fiber length and specific gravity in wood of Acacia millissima stands of various density.) Bull. Tokyo Univ. For. No. 65: 107-123. (Ja, en).
From Forestry Abstracts: "Fibre length, sp. gr. and volume and weight increment were studied in sets of disks cut from the stems of two sample trees each from three stands of A. mollissima (A. mearnsii) planted in Izu peninsula (S.-central Honshu) in 1952-55. The plantations were established at densities of (a) 1000, (b) 3000 and (c) 10 000 seedlings/ha respectively. Fibre length and sp. gr. did not differ significantly between samples from the N., E., S. and W. sides of disks and were not significantly correlated with stand density, but differed significantly between sample trees. Mean fibre length varied from 664.2 to 813.4 µm, and fibre length increased outwards from pith to bark. Mean sp. gr. varied from 0.622 to 0.689, and tended to increase from the pith outwards. Weight increment of the sample trees was influenced by volume increment during the early stages of growth, but was often related to sp. gr. when the wood was mature. The total volume and weight of the stemwood produced by the stands at densities (a), (b) and (c) respectively were: 84.4 m^3, 55 t; 103.6 m^3, 70 t; and 85.8 m^3, 58 t. Tables and figures have English captions."

Gouttin, P. 1974. (Spacing.) For. Privée Fr. No. 99: 31,33. (Fr).
From Forestry Abstracts: "Discusses the economic, silvicultural and management implications of planting softwoods (e.g. Spruce) at a wide spacing (3x3 m) and managing the crop for production of sawtimber only and not for sawtimber + pulpwood, pitprops etc. (which no longer fetch a reasonable price in France)."

Gramada, S.; Butoi, V. 1972. (Interplanting ornamental and woody species and Christmas trees in plantations.) Rev. Padurilor. 87(4): 195-196. (Ro).

From Forestry Abstracts: "Describes a profitable system used in a young seed orchard consisting of grafted clones of Pinus nigra and Larix decidua planted at 5x5-m spacing in S. Rumania: a double row of Pseudotsuga menziesii Christmas trees has been planted between the rows, the remaining space being filled with Buxus sempervirens hedging stock."

Griess, O. 1979. (Stocking of spruce (Picea abies).) Allg. Forstztg. 90(4): 84-86. (De).
From Forestry Abstracts: "The relations between stand density and either the d.b.h. or the ht. of the b.a. mean tree are shown in graphs based on data for 441 stands at 500-1400 m alt. in 3 growth regions of Austria. Optimum ranges for stem numbers and spacing are tabulated in terms of top ht. or the d.b.h. or ht. of the b.a. mean tree. The d.b.h./ht. ratio of the mean tree (67-90) did not vary significantly between growth regions and age classes."

Grigor'ev, V.P.; Gvozdev, V.K. 1978. (Increasing the effectiveness of biological improvement by thinnings.) Lesn. Khoz. 2: 17-18. (Ru).
From Forestry Abstracts: "Perennial lupins were introduced between the rows of a 3-yr-old pine (Pinus sylvestris) plantation established at an initial density of 10 000 plants/ha. The lupin biomass increased to 30-35 t/ha, but after the pine closed canopy it declined, being only 1.5-3 t/ha when the plantation was 13 years old. (In 1974) five thinning treatments were compared, viz. selective thinning (removing 15-18% of the trees by vol.); removing every fifth row; removing every fifth row plus selective thinning in the remaining rows; removing every third row; and removing alternate rows. Data are tabulated on the wt., ht., and cover of the lupin up to 1976 in the thinned plots and in unthinned controls. The thinnings had a considerable beneficial effect on the lupin, prolonging its useful period of biological improvement for 5-7 yr."

Gurgel Filho, O.A. 1973a. (Effect of density, stocking and structure of pure even-aged stands of conifers on the commercial value of the yield.) Sao Paulo, Inst. Flor., Bol. Têcn. 4. 44 pp. (Pt, en).
From Forestry Abstracts: "A synthesis of data from the literature and (mainly) from plantations of Pinus elliottii var. elliottii in Brazil, much of it already published by the author. Details are given of the effect of spacing on increment in height, diameter and volume, and on wood quality, and general conclusions are drawn on spacing, timing and number of thinnings, etc."

Gurgel Filho, O.A. 1973b. (Biology of the growth of pure even-aged forest stands, and conclusions for thinning.) Bras. Flor. 4(13): 37-42. (Pt).
From Forestry Abstracts: "Describes a method of sampling to determine the timing of the first thinning in plantations before growth starts to stagnate. The method is based on comparison of the mean diameter of the trees in each of the three outer rows of the plantation, and also that of the trees in the interior of the plantation. It is illustrated by data for two plantations of Eucalyptus citriodora of different initial density in Brazil. The mean diameter of the trees in the third row is shown not to differ significantly from that of the trees in all the interior rows in the plantation. The first thinning should be carried out when the mean diameter of the trees in the second row differs from (i.e. exceeds) that of the trees in the third row by >10%."

Gurgel Filho, O.A. 1975. (Indigenous species). Silvic. em Sao Paulo 9: 47-52. (Pt, en).
From Forestry Abstracts: "Gives information on the growth in height, d.b.h. and volume of nine indigenous Brazilian tree species (Araucaria angustifolia, Centrolobium tomentosum, Peltophorum vogelianum, Hymenaea stilbocarpa, Caesalpinea leiostachya, Platycyamus regnellii, Balfourodendron riedelianum, Esenbeckia leiocarpa and Aspidosperma polyneuron) based on more than 20 years' research at Santa Rita do Passa Quatro Forest Experimental Station, Sao Paulo. The effect of type of branching on the behaviour of these species is also discussed, and prescriptions for initial spacing in plantations are included, together with data on annual increment in m³/ha."

Gurgel Filho, O.A.; Corsini, C.A. 1973. (Silvicultural characters of Eucalyptus citriodora.) Bras. Florestal 4(14): 14-18. (Pt).
From Forestry Abstracts: "Gives results of a plantation spacing trial in Sao Paulo, Brazil, in which E. citriodora was planted at 3x1.5, 3x2, 3x2.5, and 2,3 m. Total volume at 4½ years was 225, 201, 186, and 161 m³/ha respectively. Mean diameters were 107, 115, 124 and 128 mm respectively."

Gurgel Filho, O.A.; Veiga, A.A.; Kronka, F.J.N. 1970. (Information on thinnings in Pinus elliottii var. elliottii and P. caribaea var. hondurensis.) Bras. Flor. I(3): 61-65. (Pt).
From Forestry Abstracts: "Tabulates mensurational data for plantations aged 7 years obtained at the first thinning, at nine different sites in Brazil. All the plantations were established at an initial spacing of 2x2 m. M.a.i. (volume) per ha for P. caribaea var. hondurensis averaged 32.90 m³ o.b. at sites below 23°S., and 35.80 m³ o.b. at sites north of 23°S.; corresponding figures for P. elliottii var. elliottii were 17.47 and 10.06 m³ o.b."

Hallik, J. 1977. (Growth of spruce on Vaccinium myrtillus site types.) Metsanduslikud uurimused 13: 88-103. (Ee, ru, en).
From Forestry Abstracts: "Data for 8- to 12-yr-old spruce (Picea abies) stands in Estonia show highest survival for plantings of 2000 and 3000 stems/ha, but best ht. growth at 3000 or 4000 stems/ha on heavier soils of this site type. Sites of this type on former arable land, newly felled areas with heavy soils, and meadow and pasture are suitable for spruce; others should be planted with pine (Pinus sylvestris). Birch (Betula alba) and aspen (Populus tremula) are the main competitors."

Halupa, L. 1972. (Methods of poplar growing and (their influence on) utilizable assortments.) Kisérletügyi Közlemenyek Erdögazdasag és Faipar. 63(1/3): 17-28. (Hu).
From Forestry Abstracts: "Proposes that the best time to make the first thinning in stands planted (in Hungary) at spacings between 2x2 and 3x3 m is after the trees reach a mean d.b.h. of 10 cm. Earlier felling is uneconomic owing to the lower yield and decreased ratio of profitable assortments; later felling results in a permanent loss of increment. The first thinning should remove 50% of the stems; the second should remove half the remaining stems, to leave 25% of the original number. This ratio similarly gives an optimum balance between the value of assortments produced and the future increment. Mistakes made in the first thinning can be largely corrected in the second."

Halupa, L.; Kiss, R.; Patotás, F. 1975. (Model yield tables for poplar stands.) Erdesz. Kut. 70(1): 49-58. (Hu, de).
From Forestry Abstracts: "Revised yield tables for fast-growing tree species are recommended to be in the form of 'wood production models' in which the spacing and thinning system is specified for a given species. Model yield tables are presented for Populus 'I-214' (6 site classes) planted at 5.2x3 m spacing and thinned once to a hexagonal (equilateral) spacing of 6 m by removing 50% of the stems. No thinning is done in the 2 lowest site classes."

Hamilton, G.J.; Christie, J.M. 1974. Influence of spacing on crop characteristics and yield. UK, For. Comm. Bull. No. 52. iv+91 p.
From Forestry Abstracts: "Analyses data from experiments begun in 1935-36 by the UK Forestry Commission on the effects of initial spacing (up to 2.4x2.4 m rectangular spacing) of Pinus sylvestris, Picea sitchensis, P. abies, Larix decidua, L. leptolepis and Pseudotsuga menziesii. The effects of spacing on mortality, height growth, basal area production, volume production, d.b.h., form and taper, and assortments were analysed separately; results are shown in graphs. Yield models for three yield classes of thinned and unthinned stands of each species (except L. decidua and P. menziesii) planted at various spacings are presented in appendices."

Hannelius, S. 1978. (Initial spacing in Norway spruce - an appraisal of yield and profitability.) Inst. For. Fenniae, Fol. For. No. 359. 51 p. (Fi, en).
From Forestry Abstracts: "Studies on good sites in S. Finland (with 1250-5000 plants/ha) showed that d.b.h. and ht. were best at low densities, b.a. and vol. were best and taper least at high densities, and profitability greatest at 1500-1800 plants/ha."

Hapla, F. 1981. (Effects of various spacings on the wood properties of Douglas fir.) Forstarchiv 52(4;5): 134-143; 186-190. (De, en).
From Forestry Abstracts: "Results are presented of studies of core samples taken at 1.3 m ht. from 100 trees (2 samples/tree) in each of 6 unthinned pure Douglas fir stands, aged 19-23 yr, in Forest Districts Wittlich-Ost and cochem (Rhineland-Palatinate; Eifel growth zone) which had been established at spacings of: (a) 1.5x1.5; (b) 2.5x1.2; (c) 2.0x2.0; (d) 2.3x2.0; (e) 3.0x2.5; or (f) 3.0x2.8 m. Av. ring width and absolute amount of late wood increased with increasing spacing, decreased with decreasing sociological (Kraft) class, and decreased with increasing age (ring width was greatest at age 10-12 yr). Relative % late wood was in general n.s.d. in relation to spacing/Kraft class. Oven-dry densities were significantly lower for (e) and (f) than for other spacings, and were n.s.d. in relation to Kraft class. Significant correlations were found between oven-dry density and ring width (except in (a) and (c)), and relative % late wood (especially (c)-(f)). Increased spacings were correlated with increased d.b.h. and % crown, and decreased ht./diam. ratios and crown lengths. Silvicultural recommendations include establishment of 2500-3500 plants/ha in square spacings of 1.8-2.0 m or row spacings of 1.5-1.8x2.0 m."

Harms, W.R.; Lloyd, F.T. 1981. Stand structure and yield relationships in a 20-year-old loblolly pine spacing study. South. J. Appl. For. 5(3): 162-166.

From Forestry Abstracts: "(See FA 37, 6726) Further results from a study established in 1956-7 in S. Carolina to assess 4 spacings (6x6 ft, 8x8 ft, 10x10 ft, and 12x12 ft). D.b.h. and ht. were measured for all surviving trees at 20 yr old. Max. merchantable vol. (3887 ft^3/acre) and a near max. b.a. (187 ft^2/acre) was produced by the 8x8 ft spacing. All but the 6x6 ft spacing had sawtimber at age 20 in contrast to all but the 12x12 ft spacing at age 15, and sawtimber vol. and survival both increased with spacing. The 8x8 and 10x10 ft spacings both promoted pulpwood and sawtimber production, utilization of all surviving trees, and an early return from thinning."

Haron, B. Hj. Abu Hassan. 1978. Early growth of Pinus caribaea var. hondurensis in Kemasul pine plantation, Mentakab, Pahang. Pages 141-151 in Proc. Sixth Malays. For. Conf., 1976. Kuching, Sarawak. For. Dep. Vol. 2.
From Forestry Abstracts: "A report on the large-scale planting of P. caribaea for pulpwood in Peninsular Malaysia on cleared forest sites; 305 acres were established in 1974/75 and 901 acres in 1975/76 at 690 trees/acre. Trials showed that: 4-5 oz of rock phosphate per tree were required for adequate survival, a higher rate than expected; pulling up weedy shrubs (mainly Macaranga spp.) manually at 3-4, 12 and 24 months after planting improved tree growth, while allowing the Macaranga spp. initially to shade out more pernicious weeds (Mikania and Imperata); cover crops (Stylosanthes gracilis, etc.) proved unsuccessful."

Hasan, S.M.; Al-Saraf, M.J.; Khalil, M.T. 1980. (Comparative studies on the growth of Pinus brutia in pure and mixed plantations.) Mesopotamia J. Agric. 15(1): 61-73. (Ar, en).
From Forestry Abstracts: "In trials in a semi-arid poor soil in Hammam Al-Alil, Mosul, Iraq, 2-yr-old P. brutia transplants were planted in two blocks at 1x1 m spacing. One block was interplanted with 1-yr-old Acacia farnesiana. There was n.s.d. in growth of P. brutia between the 2 blocks at the end of the first or second year, but ht. growth in the mixed stand was significantly greater than in the pure stand after 3 growing seasons."

Hattemer, H.H.; Andersson, E.; Tamm, C.O. 1977. Effects of spacing and fertilization on four grafted clones of Scots pine. Stud. For. Suec. No. 141. 31 pp. (En, sv).
From Forestry Abstracts: "The trial was established in 1963 near Stockholm, Sweden, with two spacings (1.3x1.3 m or 1.95x1.95 m) and annual treatment with NPKCaMgS fertilizer or no fertilizer. Analyses of many traits in 1967 and 1969 showed that fertilizer treatment strongly affected stem diam., branch length and diam., cone setting and needle length; spacing affected branch and stem diam.; and cloning affected branch angle and, to some extent, dimensions and cone numbers."

Haveraaen, O. 1981. (Growth development in a 20-year-old spacing experiment with Picea abies.) Norges Landbruks-høgskole, Meld. 60(13). 12 pp. (No, en).
From Forestry Abstracts: "An experiment in Norway with a Czechoslovakian provenance included the following treatments: 1.5x1.5 m, 2.0x2.0 m, 1.5x3.0 m, 2.5x2.5 m, 3.0x3.0 m and 3.75x3.75 m. A significant relationship was established between spacing and mean diam. when all the trees in each diam. class were included, but not when only the biggest trees were

included. No significant relationship was found between spacings and tree ht., but the mean ht. of the 500 or 1000 tallest trees/ha includes nearly all the most widely-spaced trees. The importance of a great number of trees to achieve higher volume production at an early stage (20 yr) is statistically significant and so are the relationships between mean crown ht. and branch diam. for the different spacings. The trees, whose age at b.h. is about 12 yr, are now growing fast."

Haverbeke, D.F. van. 1977. Conifers for single-row field windbreaks. USDA, Forest Serv., Rocky Mt. For. Range Exp. Sta., Res. Pap. RM-196. 10 pp.
From Forestry Abstracts: "Each of 5 species combinations: (a) Pinus ponderosa; (b) P. ponderosa and Juniperus virginiana; (c) P. sylvestris; (d) P. sylvestris and J. virginiana; and (e) J. virginiana were planted in north central Nebraska with 2+1 seedlings at spacings of 4, 6 and 8 ft and were either fertilized after planting or left unfertilized. Survival after 12 growing seasons was over 95% for all treatments. Ht. increment of all species was best at the 4-ft spacing. Combinations (c), (d) and (e) had the best ht. increment. Fertilizers had no effect on survival or growth. The most suitable species was J. virginiana, followed by P. sylvestris, then P. ponderosa. Recommendations are made for species combinations, spacings and thinning regimes for the early establishment and sustained effectiveness of shelterbelts."

Heilman, P.E.; Ekuan, G. 1979. Effect of planting stock length and spacing on growth of black cottonwood. Forest Sci. 25(3): 439-443.
From Forestry Abstracts: "Populus trichocarpa stem cuttings of length (a) 0.5 m (without terminal bud), and (b) 2.4 m, or (c) 4.6 m (with terminal buds), were planted in fine sandy loam along the Puyallup River in western Washington. Ht. and d.b.h. at 6-yr-old were greatest for (c), but differences were not as great as those at planting. Frequency and degree of crook were greater in (b) and (c), occurring in over 90% of (c), and were mainly due to growth irregularities in the first year. Ht. increment and d.b.h. were less at wide spacings (3.0-6.1x9.1 m) than at 3.7x3.7 m spacing. From authors' summary."

Heilman, P.; Peabody, D.V., Jr. 1981. Effect of harvest cycle and spacing on productivity of black cottonwood in intensive culture. Can. J. For. Res. 11(1): 118-123. (En,fr).
From Forestry Abstracts: "The effet of rotation time and spacing on two plantations of Populus trichocarpa in Washington, USA was investigated over 8 yr. At the poorer site the combined yield from 2 harvests at 4-yr intervals was only 75% of the yield from the harvest at 8 yr. Biomass m.a.i. was 6.05 t/ha (4-yr rotation) and 8.05 t/ha (8 yr). At the more productive site, biomass m.a.i. was 5.8 t (first 2-yr harvest), 8.9 t (second 2-yr) harvest) and 9.7 t (final harvest at 8 yr). Highest productivity over 8 yr for 2- and 4-yr cycles was obtained with 30x30 to 61x122 cm spacings; productivity from a single 8-yr harvest was highest for 16x122 cm spacing. However, at both sites the effect of spacing declined with age. From authors' summary."

Heilman, P.E.; Peabody, D.V., Jr.; DeBell, D.S.; Strand, R.F. 1972. A test of close-spaced, short-rotation culture of black cottonwood. Can. J. . For. Res. 2(4): 456-459. (En, fr).

From Forestry Abstracts: "Gives results of a study of the effect of two fertilizing and spacing (0.3x0.3, 0.61x0.61 and 1.22x1.22 m) on the yield of Populus trichocarpa in two successive 2-year rotations in Washington. Yield in the first rotation was affected by spacing and fertilizing, as being greatest with the closest spacing, whereas in the second rotation the yield was not significantly affected by spacing. Average , 8.9 t fresh-weight yield was 13.4+5/ha/year in the first harvest and est 20.9 t/ha/year in the second. Initial fertilizing with N and NPK x30 to improved growth in the first rotation but not in the second. During the first year, triazine herbicides controlled weeds but caused slight damage to the plants. Although there were no significant differences in yield between the herbicides, the survival and first-year height growth were lower with atrazine than with propazine or simazine."

Herrera, J.C. 1971. (Growth of plantations of Tipuana tipu established with different initial spacings in Santiago del Estero.) Pages 621-624 in (Proc. of the First Argentine Forest Congress - 6 to 11 Oct., 1969. Session B-IV. (Trials of various species).) Serv. Nac. For., Buenos Aires. (Es).
From Forestry Abstracts: "Comparisons of 18-year-old plantations with initial spacings of 1.5x1.5 and 2.5x2.5 m.

Hochmut, R.; Manso, D.M.; Valdés, E. 1974. (The effect of some silvicultural treatments on the intensity of attack on pines by Dioryctria horneana.) Baracoa 4(1/2): 64-71. (Es, en, fr).
From Forestry Abstracts: "The intensity of attack by the Pine tip moth D. horneana on two Pines (Pinus cubensis and P. caribaea var. caribaea) in eastern Cuba was studied in relation to various methods of fertilizer application and dosages of fertilizer, and to different initial plantation spacings. The results showed that a wide spacing was favourable to D. horneana, and that the population of the insect increased with increasing dosage of NPK fertilizer."

Hopkins, E.R. 1971. Early responses to thinning in stands of Pinus pinaster. For. Dep. W. Aust., Res. Pap. 6. 5 pp.
From Forestry Abstracts: "A 19-year-old plantation of Pinus pinaster in W. Australia, established at 6x6-ft spacing, was thinned to densities of 160, 107, 71, 47 and 31 ft² b.a./acre on each of three areas of different site quality. Treatments were replicated twice on 0.1-acre plots. Aluminium band dendrometers were fixed at a height of 5 ft to 5 of the 10 crop trees in each plot. Measurements were made at 2-week intervals from Nov. 1965 to Jan. 1968. Increment increased with increasing thinning intensity; the greatest increment occurred in spring (July-Nov.). Significant differences in seasonal growth between years were largely related to variations in rainfall. The response to thinning in all density classes appeared to be independent of site quality."

Hoyer, G.E.; Russell, K.W. 1976. Attaining intensive management goals by stems-per-acre control in plantations. Wash. Dep. Nat. Res., DNR Notes No. 12. 6 pp.
From Forestry Abstracts: "Describes one of the management regimes specified by the Department of Natural Resources, Washington, for Pseudotsuga menziesii pulpwood stands, which involves planting at spacings that will provide the number of stems/acre desired at age 15 years without the

precommercial thinning hitherto prescribed at that age. This requires allowances to be made for mortality, varying with stand age. Estimates and causes of mortality for the periods 0-5 years, 5-15 years, 15 years to first commercial thinning (at d.b.h. 6-8 inches), and a commercial harvest to final clear felling are tabulated, and the number of stems/acre required to be planted is calculated for 4 different site indexes."

Hoyle, M.C. 1975. High yield birch-nurture and nourish. North. Logger 24(1): 20-21, 36-38.
From Forestry Abstracts: "Describes the establishment and promising early growth of experimental plantations of (a) Betula papyrifera and (b) B. alleghaniensis, planted at 20x20-ft spacing on a clear-felled hardwood site in New Hampshire in 1972 and treated by careful weeding, pruning and applications of lime and NPK fertilizer in each of the first three years. The mean height reached by (a) and (b) respectively after three growing seasons (5.0 and 4.3 ft) was 52% and 30% greater than for untended and unfertilized controls."

Husain, A.M.M.; Ponnuswamy, P.K.; Viswanathan, M. 1980. Nutrient studies on black wattle. I. Effect of different NPK fertilizer combinations up to the 6th year. Indian For. 106(6): 397-402. (En, hindi).
From Forestry Abstracts: "Trials were established at 2.5x2.5 m spacing in the grasslands of the Nilgiris Plateau, Tamil Nadu, with 7 different fetilizer treatments applied to the planting pit. Measurements were made 5-6 yr after planting of contents of bark tannins (a), non-tannins (b) and total solubles (c), of moisture retention of dry bark (d) and of bark thickness (e); stem diam. o.b. (f) was measured from the 2nd year after planting. Application of N+P+K (45 g $(NH_4)_2SO_4$ + 90 g superphosphate + 45 g KCℓ) at establishment gave best results: (a) was significantly greater in the 6th yr (by 13%), (d) and (e) in the 5th (by 10 and 23% respectively) but not in the 6th, and (f) in the 3rd (by 54%) but not subsequently."

Hyun, S.K.; Hwang, J.W.; Lee, D.K.; Hyun, J.O. 1974. The growth performance of Italian poplar clones (Populus euramericana cv. I-214 and I-476) in Korea. Inst. For. Genet., Res. Rep. 11: 13-31. (En, ko).
From Forestry Abstracts: "Reports the performance of plantations 4-10 years old of either clone at 84 sites all over S. Korea, with different site characteristics and spacings, and an investigation of wetwood formation in the heartwood. Stem analyses showed that P. 'I-476' outgrows P. 'I-214' at least up to 8 years old, although the difference was strongly affected by plantation conditions. In one trial, P. 'I-214' was definitely superior to the fast-growing local hybrid formed from naturalized P. deltoides with P. nigra var. italica. High yields were obtained from Italian poplars only on alluvial sites; plantations on hillsides of compact soil were virtual failures. A spacing of 1.8x1.8 m is recommended for pulpwood production (yielding 318 m^3/ha at 9 years old); 3x3-m spacing is recommended for sawlogs and veneer logs, with heavy thinning for pulpwood at 5-7 years old. Wetwood was due to a simple bacterial infection with no evidence of wood decomposition and no significant decrease in sp.gr."

Iliev, S. 1973. (Effect of planting density on the height growth of some willows in stoolbeds for the production of cuttings.) Nauchni Trudove,

Vissh Lesotekhnicheski Inst., Sofiya (Gorsko Stopanstvo) 19: 123-129. (Bg, ru, de).
From Forestry Abstracts: "Presents data for 3 years on the survival and height increment during the growing season of cuttings of Salix cinerea, S. fragilis and S. viminalis planted at spacings from 0.6x0.3 to 1.2x1.2 m. Height increment was greatest at the wider spacings in S. fragilis and S. cinerea, but not in S. viminalis. In a single year's results for S. americana daphnoides, height growth was best at spacings of 1.2x0.6 and 1.2x0.3 m."

Iliev, A.; Bogdanov, B.; Iliev, S. 1975. (The effect of planting density on growth and and yield of poplar plantations.) Gorskostop. Nauka. 12(2): 59-64. (Bg, ru, de).
From Forestry Abstracts: "Poplar plantations (mainly Populus 'Regenerata' and P. 'Serotina') were established in Bulgaria in 1958 at eight square spacings ranging from 3x3 m to 10x10 m. Details are given of growth up to 1973. Total volume production and m.a.i. were highest, and virtually the same, at spacings of 3x3, 4x4 and 5x5 m (viz. volume 360 m^3/ha, m.a.i. 23 m^3/ha), and declined with increasing spacing, to values of 262 m^3/ha and 16.4 m^3/ha respectively at 10x10 m. The best spacings are 5x5 to 7x7 m for production of large timber and 3x3 or 4x4 m for production of medium-sized timber."

Il'inskii, V.D.; Morozova, I.A. 1975. (The main forestry activity in integrated forestry and hunting enterprises.) Lesn. Khoz. 5: 73-78. (Ru).
From Forestry Abstracts: "Discusses the constraints on forestry operations in integrated forestry/hunting enterprises in the USSR. The forestry operations considered are shelterwood fellings, small and large clear fellings, clear fellings on narrow strips, cleanings, early and late thinnings, and plantation establishment. The operations are discussed in relation to their direct immediate effect on the game (deer, wild boar, game birds) and also their long-term effect in modifying the hunting grounds. General conclusions are that large-scale clear fellings should be avoided; in montane forests, and where boar and red deer are the main game, shelterwood felling should be preferred; in central and northern regions of the USSR, clear felling in narrow strips is recommended; tending fellings should aim at achieving a suitable proportion of Aspen and Willow, and later thinnings should seek to produce a well developed underwood and ground vegetation. Pure conifer plantations should be avoided, and in areas of high game populations the plantations should be established at very close spacing (10 000-15 000 planting places per ha)."

Incoll, W.D.; Opie, J.E.; Aeberli, B.C. 1979. Effects of spacing on rate of machine planting of radiata pine. Aust. For. 42(3): 176-180.
From Forestry Abstracts: "Factorial trials were performed in 2 Victoria Forest Districts to determine the effects of planting density (749, 1683 and 4305 trees/ha) and 'rectangularity' (the ratio between row spacing : within-row spacing - 1:1, 2:1 and 4:1). Differences between the districts were negligible; the area planted per crew hour increased with increased rectangularity for a given density, and with decreased density for a given rectangularity. From the mathematical model constructed it was determined that there would be a cost saving of 23% if 3.65x1.82 m planting was used rather than 2.4x2.4 m and a cost saving of 30% ($33 for the example given)

if square planting of 3 m were used instead of 2.4 m. If spacing inadvertently decreased from 2.4 m to 2.1 m, density would increase from 1680 to 2267 plants and the total extra cost would be 27%."

Ionescu, A.; Bakos, V. 1971. (The execution of afforestation schemes.) Rev. Padurilor. 86(3): 119-21. (Ro).
From Forestry Abstracts: "Discusses the application of the principle of planting at relatively wide spacings to 11 fast-growing species (including 4 hardwoods) planted in Rumania, with recommendations."

Ipatov, L.F. 1980. (The growth of S.V. Alekseevs trial plantations of Scots pine established by planting.) Lesn. Zh. 5: 10-15. (Ru).
From Forestry Abstracts: "An account is given of the performance of plantations established on old felled areas in the Archangel region in 1949. The method of establishment was by preparing patches (0.3x0.3 to 2x2 m in size, but mainly 1x1 m) with a mattock, and planting various numbers of Scots pine seedlings in each patch; the planting density ranged from 1 plant in patches of 0.3x0.3 m to 80 plants in patches of 2x2 m, and from 5 to 20 plants in patches of 1x1 m. The spacing of the patches themselves varied, being generally between 4x2 m and 5x4 m. Data are presented on the initial survival and on the mensurational details of the plantations after 30 yr. Almost all of the 15 plantation variants achieved success in producing a stand with pine the main species. In general, the variants with very large numbers of seedlings per patch (so-called 'nest' plantings) did not do so well; the important factor in achieving plantation success was rather the number of patches per ha."

Ivanov, S.M. 1974. (Growth and condition of Picea abies plantations in the Lipetsk region.) Lesn. Khoz. 1: 43-45. (Ru).
From Forestry Abstracts: "Presents data on the performance of P. abies plantings in the forest-steppe zone of s. central Russia, where the species was first tried more than 100 years ago. Results show that P. abies has acceptably rapid growth in stands initially planted at a density of 2500-5000 plants/ha on fresh (fairly moist) grey forest sandy-loams and clay-loams, and on degraded chernozem. For example, m.a.i. of 4.6 m^3/ha at age 58 years or 6.6 m^3/ha at 38 have been recorded."

Jacquemin, A. 1973. (Japanese larch under the present economic conditions (in Belgium).) Bull. Soc. R. For. Belg. 80(10): 402-405. (Fr).
From Forestry Abstracts: "Reviews the growth of, and economic prospects for, the many stands of Larix leptolepis planted, usually at a spacing of 1.50x1.50 m, in the Ardennes and elsewhere in Belium during the last 10-25 years, with particular reference to the urgent need for thinning even if, as is probable, this involves a financial loss. If left unthinned, the plantations will not produce a saleable crop of sawtimber. For future plantations the spacing must not be <2x2 m."

Jakobsen, B. 1979. (Preliminary results from spacing experiments in Norway spruce.) Forstl. Forsogsvaes. Dan. 36(3): 403-411. (Da, en).
From Forestry Abstracts: "Results of 10 experiments (of which 2 were abandoned) established between 1964 and 1976 at spacing of 1.25 to 3.25 m showed no relationship between spacing and mortality and only a slight tendency towards greater top heights with wider spacings. But woody weeds, especially birch, were a greater problem with the wider spacings and at

spacing over 1.75 m, damage to leaders, attributable to various causes, became more frequent."

Jeschke, S. 1977. (Artificial regeneration of beech in Wolfskuhle district, Malchin State forestry enterprise, as an example of (local) silvicultural initiative.) Soz. Forstwirt. 27(7): 214-215. (De).
From Forestry Abstracts: "A note on the successful planting of 2-3-yr-old seedlings at 1.5x0.4 m spacing on a chemically and mechanically well-prepared site in Brandenburg (E. Germany) combined with interplanting of poplars at 4.5x4.5 m spacing. Owing to thorough site preparation, mechanical and chemical weed control for up to 4 yr, and the protection provided by the poplars, damage from late frost was largely avoided."

Jezewski, Z.; Malinovski, L. 1974. (Investigations on the effect of different types of planting stock and spacing on the growth of the tree willow Salix alba v. 'Sekocin'.) Prace Inst. Badawczego Lesnictwa, No. 470/475: 85-102. (Pl, ru, de).
From Forestry Abstracts: "In 1966 a trial was started on a wet site in Poland to compare the performance of six types of planting stock planted at a spacing of 2x2 m, viz. (A) 2-year plants from cuttings, transplanted after the first year; (B) 1-year plants from cuttings on 2-year roots; (C) 1-year plants from cuttings; (D) 2-year plants cut back; (E) 1-year plants cut back; and (F) 2-year cuttings. In another trial, plants of type (A) were grown at five different spacings, viz. 1x1, 2x1, 2x2, 4x2 and 4x4 m. Complete fertilizing and chemical weed control were used in the plantations. Cuttings and cut-back plants, i.e. (D), (E) and (F), produced trees with much straighter stems than the other planting stock. Details are tabulated of height and diameter growth for 5 years. Height growth was greatest with (B), next greatest with (A), (C) and (E), followed by (D) and finally (F). Diameter growth and volume production were greatest in (B) and (E). In the spacing trial, tree height in the second and third year was greatest with spacings of 1x1 and 2x1 m, but in the fifth year tree height was smallest in the 1x1-m spacing. Standing volume per ha after 5 years was greatest with the 2x1-m and smallest with the 4x4-m spacing."

Johann, K.; Pollanschutz, J. 1974. (Thinning models as an aid to decisions regarding thinning regimes and initial spacing for spruce). Allg. Forstztg. 85(11): 307-313. (De).
From Forestry Abstracts: "Discusses the results of simulations which, with the aid of computer programmes based largely on recent Bavarian thinning research, compute the effect of thinning regimes varying in intensity, timing and frequency on stands established with initial stem numbers of 7500, 5000 or 2500 stems/ha. Development of stem numbers, top and mean height, diameter, total and assortment volumes, and financial results of intermediate and final fellings (in terms of costs and proceeds per 100 ha of normal forest, and in terms of costs per m) are discussed. The simulations show clearly that volume and net value of production are better where stem numbers are relatively low initially or are reduced at an early age; they also show that both top and mean height at age 100 increase with reduction of initial stem numbers and intensity of stem number reductions. Recommendations for thinning of existing stand are given."

Johann, K.; Pollanchutz, J. 1980. (Profitable thinning: dream or reality? Main conclusions from the FPP-study 'The influences of growing space regulation on the operational success of spruce management units'.) Allg. Forstztg. 91(11): 310-314. (De).
From Forestry Abstracts: "A computer simulation program (STAOET) was used to evaluate various thinning treatments for Picea abies. Treatment varied in: initial number of trees/ha (2500 vs. 5000); thinning intensity (weak, very strong, or graduated, i.e. early thinning strong, later weak); age (from 15 to 50 yr) at first thinning; and age and number of later thinnings. Preliminary, final and total harvests were evaluated in terms of: vol. (total, small timber, and log timber), mean diam. b.h., av. vol./tree, and net value. Effects of varying site class index, rotation time, and timber cost/price structures (of small timber vs. log timber) were also studied. Low initial number of trees/ha and/or early reduction in tree number tended to give markedly higher final log timber vol., av. d.b.h., av. vol./tree, and net value; resistance to snow damage also increased due to decrease in ht./diam. ratio."

Kairyukshtis, L.A.; Yuodval'kis, A.I. 1975. (Optimum density of young Picea abies stands.). Lesn. Khoz. 2: 18-22. (Ru).
From Forestry Abstracts: "Discusses the changes in intraspecific influences (i.e. the effect of the trees on one another) during the life of Spruce stands, and presents data on the survival, growth and development of young stands (14 and 18 years old) planted at various initial densities ranging from 820 to 100 000 plants/ha. From these data, an expression is developed showing height increment (y) in relation to number of trees per ha (x), viz. $y = 162 - 11.6 \log x$. The data also indicate the existence of a critical distance between crowns (y, in cm), at which intraspecific influences begin; the critical distance y depends on tree height (x, in m) as follows; $y = 73.249 - (24.769/x) \log x$. The optimum number of trees per unit area (N) is calculated as : $N = 12080/(D + 0.73 - 0.25/H)^2$ where D is crown diameter in m, and H is mean height in m (in the range 0.5-5.0 m). A table is presented to show the optimum number of trees per ha in young Spruce stands in relation to mean height; this ranges from 2500 trees/ha at mean height 1.5 m, to 1690 trees/ha at mean height 5.0 m."

Kantemiror, Z. Kh. 1975. (Trial in growing Pinus strobus in the foot hill zone of N. Osetia.) Lesn. Khoz. 7: 17-18. (Ru).
From Forestry Abstracts: "A note on a trial started in 1952 in the Caucasus region of the USSR, when a pure plantation of P. strobus was established with 2 + 0 seedlings at a spacing of 1x1 m, on a soddy podzolized dark-brown soil on a plateau at 750 m alt. The average annual precipitation is 840 mm, and length of growing season 183 days. Mensuration details of the plantation are presented (data for P. sylvestris given in brackets for comparison): mean height 18.2 m (9.0), mean diameter 18.3 cm (8.0, b.a. 24 m^2/ha (18.5), standing volume 240 m^3/ha (90), and financial m.a.i. 11.3 roubles (4.2). P. strobus has not suffered any snow damage, and appears to be a highly promising species for this region."

Karani, P.K. 1976. Interim results of thinning research on Cupressus lusitannica in Uganda. Commonw. For. Rev. 55(1): 41-55. (En, fr).

From Forestry Abstracts: "Preliminary results from thinning trials in stands of C. Lusitanica at four sites in Uganda showed that the treatments had no effect on the height growth of dominants, which was influenced by site. Mean diameter and diameter increment of trees, except dominants, were increased by thinning. Heavy thinning reduced stand b.a. and volume increment. Trees grown at an initial spacing of 1.8x1.8 m did not need thinning before age 8 years. It is concluded that, in rotations of <35 years, the number of stems should be 300-400/ha; this density should yield a large volume of sawlogs of >40 cm d.b.h. The reduction of the rotation to 25 years should allow 500 crop trees/ha to be grown."

Kenk, G.; Unfried, P. 1980. (Branch base diameters in Douglas fir stands.) Allg. Forst. Jagdztg. 151(11): 201-210. (De, en, fr).
From Forestry Abstracts: "Crown measurements were made on crop trees in 26 stands in Baden-Wurttemberg, W. Germany, planted at various initial spacings. The av. ratio of branch length to branch base diam. was about 100:1. The branch length and crown ht. depended on the development of the crown cover of each individual tree, which varied greatly. Branch thickness at the crown base was directly related to the stem diam. in the same zone. Douglas fir branches are longer and thicker than those of Norway spruce of the same mean crown-cover radius, the max. branch base diam. considerably exceeding that of Norway spruce. A min. density of 1000 stems/ha in plantations and first pruning at a d.b.h. of about 15 cm are recommended for high-quality timber."

Kennedy, H.E., Jr. 1975. Influence of cutting cycle and spacing on coppice sycamore yield. USDA., Forest Serv., South. For. Exp. Sta. Res. Note SO-193. 3 pp.
From Forestry Abstracts: "Describes a study in Mississippi to assess the effects of rotation length and spacings on the growth and yield of Platanus occidentalis planted for pulpwood (so-called 'silage sycamore' on account of the small dimensions of the crop). Unrooted 16-in cuttings of P. occidentalis were planted in 1970 at two spacings and were harvested at intervals of 1, 2, 3 or 4 years up to 1974 (i.e. the 1-year plots four times, the 2-year plots twice and the 3-year and 4-year plots once only). Regrowth was noted after each cutting. Results show that total aboveground dry-weight yields were greater with the 2-, 3-, and 4-year cycles than with the 1-year cycle. For all cutting cycles ca. 90% of stems resprouted after harvesting. Significantly higher yields were obtained with the 2x5ft spacing than with the 4x5ft spacing for all cycles. Dry-weight yields varied form ca. 3200 lb/acre year for the 1-year cutting cycle at the wider spacing to ca. 7200 lb/acre year for the 3-year cycle at 2x5ft. No interactions were detected between spacing and the cutting cycle."

Kern, K.G. 1973. (Spacing of Scots pine in the Pfalzer Wald.) Allg. Forstz. 28(50): 1101-1105. (De).
From Forestry Abstracts: "Assessment of 24-year-old plantations established at the traditional spacings of 1.2x0.25 m (a) and at 1.5x1.5 m (b), indicated that (as expected) stems in (b) were somewhat larger, branchier, and shorter, and total b.a. was less; for trees of the same diameter, however, the diameter of the thickest dead branch was similar. Both (a) and (b) contained sufficient well-shaped trees for selection as crop-trees. The 300 final crop-trees/ha selected in (b) were larger, but about half of

them had branches of diameter >2 cm in the lowermost 4 m of the stem, vs. about one-third in (a). At 1973 prices and wages, and assuming the manual planting of 33 000 seedlings (1+0) in (a) and of 4450 plants (1+1) in (b), establishment costs per ha would be DM 6300 and DM 2000 respectively; thinning costs would differ similarly, but pruning costs would be about the same (DM 370/ha). Further trials with wider spacings are considered worthwhile."

Khizhnyak, N.I. 1974. (Features of the growth of Larix sibirica in protective stands.) Lesn. Khoz. 7: 56-59. (Ru).
From Forestry Abstracts: "Gives results of surveys of various planting of L. sibirica in the forest-steppe and steppe zones of the Volga region. The plantings are in the form of protective belts, blocks and park plantings, the oldest of which are aged 70 years. Growth and longevity (survival) of the Larch decrease considerably from NW to SE, especially in the conditions of the dry steppe, and L. sibirica should therefore not be grown in the chestnut soil zone. The Larch grows best in pure stands, or in stands with a small admixture of Lime, Ash or shrubs, at spacings of 3x1.5 or 3x2 m."

Kihlstock, N.; Lockow, K.W. 1979. (Silviculture of Pinus massoniana in Vietnam.) Beitr. Forstwirt. 13(4): 165-159. (De, ru, en).
From Forestry Abstracts: "Growing-space constants were calculated based on studies in Quang Ninh province, and thinning mode curves (stem number vs. top ht.) are presented for stands at spacings of 2x1, 3x1 (recommended), and 2x2 m. Stand establishment, tending, and thinning methods are discussed."

Kilpatrick, D.J.; Sanderson, J.M.; Savill, P.S. 1981. The influence of five early respacing treatments on the growth of Sitka spruce. For. 54(1): 17-29.
From Forestry Abstracts: "Trials were established in 1960 in Northern Ireland in which an 11-yr-old stand (site class 20 m^3/ha/yr) planted at 1.9x1.9 m spacing was respaced to give stand densities of 320-2900 stems/ha. Results are presented up to 31 yr old (top ht. 18.5 m) in the form of local yield tables. A yield model is developed to estimate vol. and other crop variables for initial densities of 1000-3000 stems/ha and top ht. 15-22 m. The model shows that by planting at 1600 stems/ha, some 62% of the vol. production would be in sizes greater than 20 cm d.b.h. (compared with 37% at 3000 stems/ha), with only 4% loss in total vol. production."

Kilimo, E. (Editor). Stability of spruce forest ecosystems. International symposim, Oct. 29- Nov. 2, 1979. Institute of Forest Ecology, Brno, Czechoslovakia. Brno, Czechoslovakia; University of Agriculture. (1980) 517 pp. (En, De, en).
From Forestry Abstracts: "Sponsored by the Czechoslovak MAB National Committee of UNESCO and Division I of IUFRO, 44 papers were presented."

Kim, D.C.; Ma, S.K. 1974. (Density effect of young stands of pitch pine. (Pinus rigida).) Korea, For. Res. Inst. Res. Rep. 21: 151-156. (Ko, en).
From Forestry Abstracts: "P. rigida seedlings were planted at 3000, 5000 and 10 000 seedlings/ha in the Kwangung Forest, S. Korea, in 1965. Tree ht., d.b.h. and green wt. of roots, stems, branches and leaves, measured in

1972, are tabulated. The d.b.h. decreased with increasing stand density, but there were no significant differences in dominant ht. Weight yield per unit area, and the % of total biomass contributed by stems, were greatest at the highest density, and there was also least variation in d.b.h. It is suggested that this density would be the most suitable for the mass production of logs of similar size. Tables and figures have English captions."

Kim, S.I.; Chae, B.C.; Whon, J.S. 1976. (Effects of planting density of mother bamboo on the establishment of bamboo groves.) Korea, For. Res. Inst. Res. Rep. 23: 39-48. (Ko, en).
From Forestry Abstracts: "The growth of Phyllostachys nigra and P. edulis planted at densities of 500, 1000, 1500 and 2000 plants/ha was studied in 1969-75 at Chinju, S. Korea. Establishment was best at 2000/ha; groves of P. nigra and P. edulis were completely established in 3 and 6 years, respectively. The tables have English captions."

Kislova, T.A. 1971. (Economic evaluation of plantations of different (initial) density.) Lesn. Zh. 14(2): (124-7). (Ru).
From Forestry Abstracts: "A theoretical analysis of the method of calculating optimum initial density, i.e. the density that results in the maximum value of produce per unit of expenditure. Equations are developed for relating various expenditures (for soil preparation, planting or sowing, beating up, and tending) to the initial density of the plantation."

Kjersgard, O. 1972. (A Norway spruce spacing trial on a heath site.) Forstl. Forsogsvaes. Dan. 33(1): 1-9. (Da, en).
From Forestry Abstracts: "Reports an assessemnt, at 30 years of age, of a trial at Pålsgard, Denmark, designed as a parallel to one already published. The spacings compared varied from 0.5x0.5 to 2.25x2.25 m. Results confirmed that diameter and height of the b.a. mean tree tended to increase, but b.a. and volume decreased, with increasing spacing."

Kloosterhuis, W.E.H. 1976. In: (Annual Report 1975, Tree Nursery Research Station, Boskoop.) Boskoop, Netherlands. 170 pp. (Nl).
From Forestry Abstracts: "Reports on propagation research, including spacing trials with 2-yr-old transplants of Pinus sylvestris and 1-yr-old transplants of Alnus glutinosa, Betula pendula, and Quercus robus..."

Koch, H. 1977. (Spacing of Scots pine in the Upper Palatinate.) Allg. Forstz. 32(14): 337-339. (De).
From Forestry Abstracts: "In a spacing trial planted in 1968 near Regensburg (Bavaria) with 2+0 Pinus sylvestris spaced at 0.4 m within and at 1.2, 1.6 and 2.0 m between the rows, evaluation in 1975 showed no significant effects of spacing on ht. and d.b.h. growth; however, the incidence of snow damage in 1974 was 30% at 1.2 m, 5% at 1.6 m and negligible at 2.0 m spacing."

Kohán, Š. 1973. (Poplar growing in the Kosice lowlands (E. Slovakia).) Act Inst. For. Zvolenensis. 4: 139-163. (De, sk, ru, en).
From Forestry Abstracts: "A comparative assessment of the growth rates, value production and susceptibility to Dothichiza populea canker of Populus 'Robusta', P. 'I-214', P. 'Gelrica', P. 'Grandis', P. 'Serotina' and P.

'marilandica', in stands 5-16 years old on semi-gleys. The importance of suitable methods of site preparation and initial spacing is stressed."

Kolster, H.W. 1978. (Clone mixtures in poplar plantations.) Populier 15(1;2): 3-11; 27-32. (Nl, en).
From Forestry Abstracts: "Preliminary results (at up to 11 yr old) are given for trial plantations established in the Netherlands on contrasting sites from 1965 onwards with two cultivars planted in alternate rows in different spacings. The clones used were Populus 'Robusta', 'Dorskamp', 'Oxford', 'Rochester', etc. Ht. growth has not been influenced, but the diam. growth of the 2 components of the mixture began to diverge when the ht. was 8 m or more, the difference increasing with age. The increased wood production of the better growing clone in a mixture did not compensate for the loss in production of the other clone (i.e. total production per ha was less than that of a pure plantation of the better clone). Row mixtures of clones are not recommended. It is suggested that the risks of monoclonal plantations would be better limited by establishing smaller plots per clone."

Kolster, H.W.; Meiden, H.A. van der. 1974; 1975. (Mini rotation for Poplars. (I). (II, Conclusion).) Populier 11;12(4;1): 63-64; 3-6. (Nl).
From Forestry Abstracts: "Describes investigations started at Hummelo, Netherlands, in 1974 on the cultivation of Poplars on very short rotations, e.g. 6-7 years. The planting stock used consisted mainly of various types of long cuttings or 1-year rooted plants of the cultivars 'Androscoggin', 'Donk', 'Barn', 'Fritzi Pauley', 'Pap', and 'Dorskamp', planted at 2x2, 2.5x2 and 3x2 m. Details are given of the lay-out of the trial plots, treatment of stock before planting (e.g. holding in water, removal of side shoots), and mortality and height growth in the first growing season (1974). Removal of side shoots before planting, and shortening (height reduction) immediately after planting appear to improve the survival and height growth in the year of planting."

Kolster, K.W.; Meiden, H.A. van der. 1979. (Wood production on very short rotations: an experimental plantation in Hummelo.) Populier 16(1): 3-7. (Nl).
From Forestry Abstracts: "Trial plantings were made in 1974 with various poplar species and spacings (2x2, 2x2.5 and 2x3 m). Despite initial losses, it was possible to calculate growth data for complete stands, which indicate that high increments are possible: Populus 'Rap.' reached an m.a.i. of 23-30 m^3/ha after 5 yr and c.a.i. in 1978 was up to 55 m^3/ha. The m.a.i. of P. 'Dorskamp', P. 'Barn', P. 'Donk' and P. 'Fritzi Pauley' was 20-25 m^3/ha. Because c.a.i. was still increasing, a 5-yr rotation appeared to be too short."

Konnert, V. 1974. (Influence of the type of mixture used in afforestation on the productivity of Robinia pseudoacacia stands in Baragan (SE. Rumania).) Rev. Padurilor-Industria Lemnului Silvic. si Exploatarea Padurilor 89(5): 232-235. (Ru).
From Forestry Abstracts: "Describes a 14-year-old trial at various spacing on a steppe site, in which a shrubby understorey was formed by coppicing the secondary hardwoods in the mixtures when they were ca. 4 years old. Understorey cover was complete with Cornus sanguinea, partial (with gaps)

with Prunus cerasifera and P. maheleb, and largely absent with Acer tataricum, Crataegus monogyna, Euonymus europacus and Ligustrum vulgare. The species in the understorey did not significantly affect the increment of R. pseudoacacia. It is suggested that the understorey may benefit the main crop after the canopy has opened out. Plantations made with an area of 1.5-6.0 m² to each plant of R. pseudoacacia were taller and more productive than those made at wider spacings."

Korobov, I.A. 1978. (Effect of tending fellings on the growth and condition of young pine stands on the sands of the lower Dniepr.) Lesoved. 4: 42-46. (Ru, en).
From Forestry Abstracts: "An account is given of thinning trials carried out on young Pinus sylvestris plantations established in 1960 by planting seedlings at a spacing of 3x0.5 m on a sand-dune area. The thinning was done in 1967 leaving 3000 or 4000 plants/ha, or 5200 plants/ha as the unthinned control. Data are tabulated on ht., d.b.h., standing vol., increment, crown projection, site class, wt. of needles, etc. up to 1976. Another thinning trials was in a plantation established in 1956 by planting seedlings at 3x0.5 m on a flat sandy site and thinned in 1960 leaving 2000, 3000, and 3500 plants/ha or 5100 plants/ha as the unthinned control. The results indicate that thinning to 3000 plants/ha means that the stands do not require another thinning for at least 16 years. Increment was best on the plots that were thinned to 3000 plants/ha."

Koss, H.; Fricke, O. 1982. (Development of Tilia cordata understorey in oak stands.) Forstarchiv 53(2): 60-66. (De, en).
From Forestry Abstracts: "Results are presented of inventories taken in 1980 in 70- to 80-yr-old stands in F. Lower Saxony in which T. cordata (age 14-29 yr) had been underplanted at oak stand age 50-60 yr. Percentage of clear/nearly clear oak boles increased with increasing number and ht. of linden; % epicormic branches in oak increased as socialogical (Kraft) class decreased. In T. cordata: ht. increased with decreasing shading; with increasing shading, radial growth decreased more than ht. growth; greater d.b.h. was correlated with increased % straight-boled trees and % upward- (vs. horizontally-) directed branches; and % live branches increased with increasing d.b.h. Silvicultural recommendations include: establishment of oak stand at spacing of 2x1 m (5000/ha) with a moderate thinning at age 25-30 yr; and underplanting of T. cordata at oak stand age 35-50 yr at a rate of 2300-4000/ha."

Kostov, K.D. 1975. (The branch length/diameter ratio in Quercus rubra, and its use in determining initial density in plantations.) Gorskostop. Nauka 12(2): 42-47. (Bg, ru, en).
From Forestry Abstracts: "In plantations up to 12 years old in NW Bulgaria, established at six different spacings (from 1.0x0.5 to 4.0x1.5 m), measurements were made of the length and diameter of the branches on the bottom 2 m of the stems. Branch diameter (Y, in mm) was related to branch length (x, in cm) as follows: $Y = 2.51 \pm 0.076$ x; r = +0.998. Initial spacing affected the absolute dimensions of the branches, but not the branch length/diameter ratio. It is suggested that these findings could be used for determining an appropriate initial spacing."

Kramer, H. 1975. (Establishment of stands with future thinning practice in mind.) In Forst-und Holzwirt 30(17): 315-335. (De).

From Forestry Abstracts: "Reviews effects of spacing, plant quality etc. on increment, quality and financial yield, and includes some interim results of a study on the effect of initial stem numbers on the quality of Scots pine."

Kramer, H. 1980a. Spacing of coniferous stands in Germany. South Afr. For. J. 113: 30-35.
From Forestry Abstracts: "The spacing of Scots pine and Norway spruce stand in W. Germany is discussed in relation to financial yield and stand quality."

Kramer, H. 1980b. Tending and stability of Norway spruce stands. In: Stability of spruce forest ecosystems. International symposium, Oct. 29 - Nov. 2, 1979, Inst. For. Ecol., Brno, Czech. Pp. 121-133.
From Forestry Abstracts: "Spacing and thinning practices in West Germany in relation to wind and snow damage."

Kramer, H. 1980c. The effect of different thinning regimes on stand stability and increment in a Norway spruce stand with wide initial spacing.) Univ. Göttigen/Niedersächs. Forstl. Versuchsanst., Schr. Forstl. Fakultat. 67: 224-235. (De, en, fr).
From Forestry Abstracts: "Six treatments were studied over 4 yr in a 55-yr-old Norway spruce stand with a spacing of 3x1.5 m: (a) light low thinning; (b) heavy low thinning; (c) heavy crown thinning; (d) a combination of line thinning and selective thinning; (e) combined line and row thinning (with rows at an oblique angle); and (f) line thinning; as well as controls (g) at 3x1.5 m and (h) at 1.5x1.5 m spacing. Considerable snow damage in the 3rd year (1978/79) was heaviest in (h) and lightest in (b). Diam. increment was greatest with heavy thinning, and was reduced with line thinning."

Kramer, H.; Bjerg, N. 1977. (Thinning in spruce stands established at wide spacings.) Forst-und Holzwirt, 32(2): 21-25. (De).
From Forestry Abstracts: "Preliminary studies in a previously unthinned 55-year-old stand in Lower Saxony, initially spaced at 3x1.5 m, showed that light or heavy low thinning was not commercially profitable. Conventional crown thinning, and removal of every 8th row plus crown thinning in between (both removing 25% in volume) more or less covered costs; and two geometrical methods of the same intensity (removing every 8th row and clearing oblique cable skidding lanes in between, and removing every 4th row) yielded a profit (at any rate if possible adverse effects on the remaining stand are disregarded). The combined row and crown thinning, which allows a high degree of mechanization without undue risks to the remaining stand, is considered a suitable compromise."

Kramer, H.; Bjerg, N. 1978. (Biological aspects of tending young stands of Norway spruce. A discussion of the spruce thinning trials in Olpe forest district.) Univ. Göttingen and Niedersächs. Forstl. Versuchsanst., Schrif. Forstl. Fak. No. 55. 121 p. (De, en).
From Forestry Abstracts: "In 1973, 3 thinning treatments were made in 28-yr-old Norway spruce stands (1.5x1.5 m spacing) in the Sauerland district, W. Germany, each consisting of double row thinning (removal of 2 adjacent rows) combined with: (a) selective thinning from above of the residual blocks of 8 rows; (b) single row thinning of residual 8-row

blocks, perpendicular to the double row thinning; and (c) unthinned residual blocks of 4 rows each. In 1975 the dominant trees on all thinned plots were pruned to a ht. of 6 m on the stem. In 1977, stand density, ht./diam. ratio, crown length ratio and b.a. increment were recorded: b.a. increment was about 9% higher in (a) than controls, and in (b) and (c) was about the same as controls. Double row thinning caused an increase in b.a. and d.b.h. increment in trees in the 3 rows nearest the edge of residual blocks."

Kramer, W. 1980. (Evaluation of E. European provenances of silver fir.) Forstarchiv 51(9): 165-169. (De, en).
From Forestry Abstracts: "Material of 9 Polish, 2 Slovakian, and 2 W. German provenances was transplanted as 2+2 planting stock to site in Forest District Syke (Lower Saxony) in 1975 (spacing 2.0x1.0 m; with Alnus incana and perennial lupins); survival and ht. performance results are presented up to age 9 yr. Provenances were ranked in relation to growth rate; those originating towards the E. and SE edges of the natural range of A. alba are recommended for establishment in N. Germany."

Krasnyatov, V.V. 1981. (Density and growth of Scots pine plantations on felled areas.) Lesn. Khoz. 10: 44-45. (Ru).
From Forestry Abstracts: "A summary account is given of the performance of Scots pine plantations in the Khabarovsk region of the Soviet Far East, established at various planting densities (2100-10 000 plants/ha). Diam., ht., standing vol., and vol. increment at ages 20, 30 and 40 yr are tabulated for each initial planting density. The best yields were in plantations established at 4100-6000 and 6100-8000 plants/ha."

Krinard, R.M. 1971. 12x12 initial spacing best in cottonwood plantations. Tree Plant. Notes 4: 17-19.
From Forestry Abstracts: "Most of the 30 000 acres of Populus deltoides plantations in the Lower Mississippi Valley had initial spacings of 9x9 ft or 10x10 ft. The present report summarizes 7 years of growth data from one such plantation, which indicate that a 12x12-ft spacing might be near optimum."

Krinard, R.M.; Johnson, R.L. 1975. Ten-year results in a cottonwood plantation spacing study. USDA, For. Serv., South. For. Exp. Sta. Res. Pap. SO-106. 10 p.
From Forestry Abstracts: "Presents data from studies in the lower Mississippi Valley on the growth in diameter and volume of Populus deltoides during the first ten years after planting (unrooted) cuttings at initial spacings of 4x9, 8x9, 12x12 or 16x18 ft, and reports the effects of various thinning treatments. Results showed that none of the spacings tried was optimum in all respects, though 12x12 ft may be the best compromise since it results in good pulpwood production, with or without thinning, good average growth of dominants and fair tree quality, and, with a slightly longer rotation, yields sawtimbers with somewhat better bole quality than the 16x18-ft spacing."

Krinard, R.M.; Johnson, R.L. 1980. Fifteen years on cottonwood plantation growth and yield. South. J. Appl. For. 4(4): 180-185.
From Forestry Abstracts: "Later results from the same study of Populus deltoides, planted at 4x9, 8x9, 12x12 and 16x18 ft spacings in the lower Mississippi valley in 1963. Some flooding occurred between 1973 and 1976

and 6 of the 32 original plots are not included in this report. Survival ranged from 25% at the closest spacing to 76% at the widest; thinning reduced mortality. On unthinned plots, av. ht. of dominants ranged from 96 ft at 4x9 ft spacing to 104 ft at 12x12. All spacings had similar total and merchantable vol. Av. annual net production of merchantable wood was 243-260 ft³/acre, with peak m.a.i. 19-52 ft³ higher in years 9 to 13. Merchantable vol. production (trees with d.b.h. greater than 5 inches) was 210-300 ft³/acre annually, and 5 of 9 spacing/thinning combinations produced more vol. than control plots. Av. annual increase in bd ft vol. in trees of d.b.h. greater than 12 inches on unthinned plots increased from 59 at 4x9 ft spacing to 369 at 16x18, and from 98 to 421 for thinned plots."

Kristinic, A.; Vidakovic, M. 1971. (Effect of dense planting on the growth of Salix alba.) Topola 15 (83/85): 37-40. (Sh, en).
From Forestry Abstracts: "Rooted cuttings of S. alba were planted in N. Croatia at 1x1, 2x2, 2x1, and 1x2 m in 1963. Data are presented on increment in height, diameter and volume, determined periodically up to 1970. It is concluded that this dense planting does not give satisfactory results."

Kuzmanovic, U. 1973. (Some results of investigations on plantations of hybrid poplar, clone I-214, on the alluvium of the Velika Morava.) Topola 95/96: 35-43. (Sh, en).
From Forestry Abstracts: "Plantations consisting mainly of Populus 'I-214' were established in Yugoslavia in 1968 with (A) 2/2 plants at a spacing of 2x1.38 m, and (B) 2/3 plants at a spacing of 2x1.61 m. Data are given on volume increment and on the economics of pulpwood production on a very short rotation. Clear felling 3 years after plantation establishment yielded 169.6 m³/ha with (A), and 170.1 m³/ha with (B), the mean d.b.h. being 10.5-11.5 cm and height 11-11.5 m."

Kuz'michev, V.V.; Savich, Y.N. 1979. (Effect of planting density on the growth of Scots pine plantations.) Lesovedenie 6: 56-63. (Ru).
From Forestry Abstracts: "Data were collected from spacing trials established on a clear-felled area with initial planting densities of 2500, 5000, 7500, 11 500, 17 500, 24 500 and 30 000 plants/ha. The plantations were left without any thinnings, and measurements were made on sample plots at ages 13, 17, 20, 24, 28 and 35 yr. Equations were derived for expressing mean diam. in relation to age and mean spacing, and the relationships are shown in tables and graphs. The results are discussed in relation to the prediction of growth and stability of pine plantations."

Laar, A. van. 1978. The growth of unthinned Pinus patula in relation to spacing. South Afr. For. J. 107: 3-11.
From Forestry Abstracts: "The study was carried out on data from a spacing trial established in 1937 in the Mac-Mac plantation, eastern Tranvaal. The Richards growth equation was applied to express b.a. and vol. production as a function of age. The estimates of the parameters of the equation were regressed on stand density, to produce 2 sets of growth curves, for live b.a. and live vol. respectively. The b.a. corresponding to the max. rate of b.a. growth and the age at which it occurs were found to increase with decreasing stand density. The effect of spacing on stem form and branch characteristics was studied on 400 sample trees. Initial spacing

significantly influenced stem form and branch vol. per tree, but not total branch vol./ha. From author's summary."

Laar, A. van; Bredenkamp, B. 1979. The effect of initial spacing on some growth parameters of Eucalyptus grandis. South Afr. For. J. 111: 58-63.
From Forestry Abstracts: "The relationship between the growth rate of E. grandis and initial spacing was studied in a replicated correlated curve trends (CCT) spacing trial on the coastal plain of Zululand. The parameters of the Richards growth equation, applied to live b.a., were regressed on nominal stand density. An analysis of ht. growth showed that both mean ht. and top ht. were related to stems/ha. The effect of stand density on crown dimensions was also determined. From authors' summary."

Ladrach, W.E. 1974. (Recommendations on initial spacing and thinning of conifer plantations.) Columbia Invest. Forestal, No. 2, 6 pp. (Es, en).
From Forestry Abstracts: "Data relating to spacing trials in USA and South Africa are presented and used as a basis for recommendation for pulpwood plantations of Pinus taeda, P. elliottii and P. patula in Colombia. As tree growth rates obtained in Colombia are up to twice as fast as those in the USA and South Africa, density recommendations taken from these countries must be adjusted considerably. Wind speed is a limiting factor, affecting thinning regimes. Initial planting density recommended for Colombia is 1100-1600 trees/ha, with thinning at 7 and 12 yr, and final felling in year 15. Basal area after thinning should fall between 18 and 20 m^2/ha."

Laidly, P.R.; Barse, R.G. 1979. Spacing affects knot surface in red pine (Pinus resinosa) plantations (in Wisconsin). USDA, Forest Serv., North Cent. For. Exp. Sta. Res. Note NC-246. 3 pp.
From Forestry Abstracts: "Quantifies the effect of spacing on branch diameter, number of branches, and Knot surface in a red pine plantations."

Lancaster, K.F.; Walters, R.S.; Laing, F.M.; Foulds, R.T. 1974. A silvicultural guide for developing a sugarbush. USDA, Forest Serv., Northeast For. Exp. Sta. Res. Pap. NE-286. 11 p.
From Forestry Abstracts: "On the basis of information in earlier papers (cf. FA 32, 6055), recommendations are made for obtaining highest possible yields of sap from Acer saccharum trees by manipulating stand density and stocking %. Silvicultural management procedures are prescribed for stands of saplings, pole stands and stands of small sawtimber; notes are included on the use of a sugar refractometer for testing sap-sugar content as a basis for selecting trees with the sweetest sap to be retained for the final crop."

Larin, V.B.; Malakhovets, P.M.; Tutygin, G.S. 1972. (Results of planting spruce on felled areas covered with hardwood regeneration.) Tr. Arkhang, Lesotekhn. Inst. No. 34: 57-60. (Ru).
From Forestry Abstracts: "Picea (abies) was planted in 'corridors' (strips) 1-6 m wide or in gaps (1x1.2 to 6x6 m), cut in Birch/Aspen regeneration on clear-felled Spruce sites in the Archangel region. Details are given of the survival and growth of the P. abies. It is recommended that in hardwood regeneration 1 1/2-5 m high, Spruce should be planted in strips ‡3 m wide, aligned N. to S. In regeneration 5 m high, planting can

be done in 6x6-m gaps, and in regeneration 1.5 m high it can be done in 4x4-m gaps."

Lear, D.H. van; Saucier, J.R.; Goebel, N.B. 1973. Growth and wood properties of loblolly pine on a Piedmont subsoil as influenced by early fertilization. Soil Sci. Soc. of Amer. Proc. 37(5): 778-781.
From Forestry Abstracts: "Reports a study in which 1+0 seedlings of Pinus taeda were planted at 2x2-m spacing on an area of 'borrow' (i.e. ground from which the topsoil had been removed, exposing a heavy clay subsoil) in South Carolina, in 1955. After two growing seasons applications of N, P and K, at a range of dosages, were made to the soil surrounding individual plants. Treatments were repeated for four consecutive years, at the end of which seedlings receiving N, either alone or with P and/or K, were significantly taller than any others. Ten years after the last fertilizer application, trees treated with N were 0.6-1.6 m taller and 23-30% larger in diameter than control trees. Wood sp. gr. and late-wood % were not altered by the treatments."

Leek, N.A. 1980. (Stand establishment in the Netherlands: an enquiry on methods of reforestation in the forest year 1976/1977.) Ned. Bosbouw Tijdschr. 52(1): 6-16. (Nl, en).
From Forestry Abstracts: "The enquiry, which covered planting (except poplar planting) on clear-felled areas in private and state-owned forests, showed that: heavy mulching machines are tending to replace site preparation by rotary cutters and windrowing of slash; soil cultivation usually means spot or strip cultivation by various mechanical methods; about 10% of the area is replanted without any site preparation; 80% of all conifers in state forests and 40% in private forests are spaced at 2x2 m; and 80% of the area is planted by hand with a semicircular spade."

Leikola, M.; Metsämuuronen, M.; Räsänen, P.K.; Taimisto, E. 1977. (The development of Scots pine plantations in south-western Finland in 1967-1975.) Inst. For. Fenniae, Folia For. No. 312. 27 pp. (Fi, en).
From Forestry Abstracts: "Results are reported from a study of 37 reforestation areas established (by planting or sowing) in 1959-1961 and surveyed in 1967/1968 and 1975/1976. Mortality reduced the number of plants from 2600-3000/ha at establishment to 780-880/ha in 1975. About 1/6 of the plantations were thought to be good, 1/2 were satisfactory and 1/3 tolerable; all were in need of cleaning/thinning."

Lemoine, B. 1980. (Stand density, competition and cooperation in maritime pine. II. Results at 5 and 10 years of a plantation with variable spacing.) Ann. Sci. For. 37(3): 217-237. (Fr, en).
From Forestry Abstracts: "Nelder type plots gave the equivalent of tests at 11 planting densities, from 876 to 78 163 stems/ha. At high densities, mortality was mainly the result of competition; as density increased, so did mortality. At low and medium densities, other factors were responsible for mortality. Vol. growth before death was lower at high densities. Density had less effect on ht. than on other parameters, only intervening at high density. There was a greater effect of density on stem girth in a closed canopy. The effect on crown size was greater at wide spacings with an open canopy. With an open canopy, current increment is proportional to canopy ratio. At high densities, mean vol. of live trees is inversely proportional to density."

Lepekhin, A.V. 1981. (Change in the mensurational indices of Scots pine stands with thinning.) Lesn. Zh. 3: 27-30. (Ru).
From Forestry Abstracts: "Three thinning treatments were applied in 1972 in plantations established in 1944 at a spacing of 2.5x0.7 m: (a) row thinning; (b) uniform selective thinning; (c) a combination of (a) and (b). Four different intensities of thinning were applied. The mensurational details of the stands are tabulated before, immediately after and 7 yr after the thinning treatments; (c) appears to be the best method."

Lewis, C.E.; McCormick, W.C.; White, W.E. 1972. Cultivation, grazing, insects and disease affect yield of slash pine in sod. USDA, Forest Serv., Southeast For. Exp. Sta. Res. Note SE-174. 8 pp.
From Forestry Abstracts: "Pinus elliottii seedlings were planted at 6x12-ft spacing on a grazed site with a uniform dense cover of carpetgrass (Axonopus affinis) in Georgia in 1958. Part of the site was disked between rows 2-3 times each summer to reduce competing vegetation. After 11 years, the growth of trees subjected to cultivation (a) was significantly better than of controls (b), but survival was low (36% in (a) compared with 76% in (b)). Cattle were allowed to graze on the site from 1959 and caused much more severe damage to (a) than to (b); the poor survival of (a) was also due to attack by Dioryctria (amatella) larvae and fusiform rust on the faster growing trees. It is concluded that cattle should not be allowed to graze an area intensively until the trees are 8 - 10 ft tall."

Lin, J.Y.-H. 1970. Growing space index and stand simulation of young western hemlock in Oregon. Astr. of thesis in Dissert. Abstr. int. 31B(5),(2397). 193 pp.
From Forestry Abstracts: "The original thesis presents a new method of assessing available space for a young tree, which allows the collection of information on an individual-tree basis from spacing or thinning plots. Results of applying a computer stand-simulation model (incorporating data from the growing-space index of the Crown Zellerbach Corporation's Hemlock thinning projects on Oregon) to 42 plots showed close agreement of characteristics between the simulated and the actual stands."

Lin, W.C. 1975. (Spacing study on taiwania plantations.) Q.J. Chin. For. 8(4): 18-27. (Ch, en).
From Forestry Abstracts: "Seedlings of Taiwania cryptomerioides were planted at 7 different spacings from 1.5x1.5 m to 3.0x3.0 m in plots at 900 m alt. in Taiwan in March 1965. After 5 yr there was no significant difference in ht. or d.b.h. between spacings, but after 10 yr d.b.h. tended to increase with spacing. Total wood vol./ha after 5 and 10 yr was highest at close spacings of 1.5x1.5 and 1.5x2.0 m, amounting to 129-151 m^3/ha at 10 yr old. Although planting costs were slightly higher for the close than for the wide spacings, the net income was 2.2-2.7 times greater from the close-spaced plots. It is recommended that taiwania be planted at spacings of 1.5x1.5 or 1.5x2.0 m. Tables and histograms have English captions."

Lisbão Junior, L. 1980. (Effect of frost, and initial performance of three Eucalyptus dunnii Maiden provenances in a combined spacing and fertilizer trial.) Brazil, Unidade Region. de Pesquisa Flor. Centro-Sul, Bol. Pesguisa Flor. 1: 28-49. (Pt, en).
From Forestry Abstracts: "Performance (3 months after planting) of NSW

(Australia) provenances was observed at Colombo, Paraná (Brazil). N.s.d. was found for frost resistance (-2.5°C occurring 14 days after planting) and survival (av. 90.2%) among provenances. Provenances differed significantly in ht. growth. Frost damage was higher (and survival lower) in plants fertilized with N and K. Greatest ht. growth was observed in fertilized plants, mainly when P was present. No significant effect of spacing was observed."

Litvak, P.V.; Evdokimow, A.P. 1977. (Plantation trials with Karelian birch in the Ukranian Poles'e.) Lesn. Zh. 5: 149-151. (Ru).
From Forestry Abstracts: "A note is given on the performance of various small trial plantations of Karelian birch (Betula verrucosa (B. pendula) f. carelica, with figured grain) in the Ukraine. The six plantations are mixed, and are 7, 10 or 15 years old; data are tabulated on the stem dimensions, b.a. and standing vol. of the birch and other species in the plantations. The results indicate that the Karelian birch cannot compete effectively in mixture with fast-growing species such as pine (Pinus sylvestris) and Quercus rubra. In open stands of Karelian birch there is an increase in the proportion of short-stemmed or shrubby forms. It is concluded that wide spacing (3x3 m) promotes the formation of Karelian birch with the typical figured grain."

Lohrey, R.E. 1972. Precommercial thinning of direct seeded loblolly pine. USDA, Forest Serv., Southern For. Exp. Sta. Res. Note SO-139. 4 p.
From Forestry Abstracts: "In 1961, nine thinning treatments were applied to 0.1-acre plots of Pinus taeda, aged 3 years, growing on a clear-felled site in central Louisiana. Initial stand density was >5000 trees/acre. The treatments were: four intensities of selective thinning; three strip thinnings to simulate machine thinning; a combination of strip and selective thinning; and an unthinned control. At age 11 years, mean d.b.h. was inversely related to stand density and directly related to the mean height of dominant and codominant trees; there was no significant difference between selective and strip thinnings. Response to thinning was most pronounced at <1500 trees/acre."

Low, A.J. 1974. Initial spacing in relation to establishment and early growth of conifer plantations. U.K., For. Comm., Res. Develop. Pap. No. 110. 14 pp.
From Forestry Abstracts: "Discusses, from the small amount of direct information available, the probable influence of initial spacing (up to 2.4x2.4 m, and equivalent rectangular spacing) on the establishment and early growth of conifer plantations in Britain. On lower, more sheltered sites, closer spacing gave no advantage over wider spacing. Most establishment costs fell with increasing spacing, except where slight or moderate beating-up was necessary at 2.4x2.4 m. On more exposed upland areas, wide spacing prevented the early development of mutual shelter. Recommended spacings are given, based on the author's conclusions. Generally it seems unwise to plant at spacings >2.1x2.1 m except on very fertile sites, and for Pines spacings >1.8x1.8 m appear undesirable."

Low, A.J.; Tol, G. van. 1975. Spacing and treatment of young stands - initial spacing in relation to stand establishment. In Symposium stand development. Proc. IUFRO joint meeting, divisions 1 and 3, Wageningen, The Netherlands, Oct. 15-19, 1974.

Lundgren, A.L. 1981. The effect of initial number of trees per acre and thinning densities on timber yields from red pine plantations in the lake states. USDA, Forest Serv., North Cent. For. Exp. Sta. Res. Pap. NC-193. 25 pp.
From Forestry Abstracts: "An analysis of data for Pinus resinosa plantations with initial densities (trees successfully established 5 yr after planting) of 50-1600 stems/acre and subsequent thinnings to give 60-180 ft²/acre residual b.a. Simulations of growth and yield were made using a program developed by the author. A series of graphs show the effect of thinning density on vol. yield for different site indices. The results show that initial density has a major effect on timber quality and quantity, with 200 stems/acre (500/ha) thinned to a b.a. of 120 ft²/acre (27.5 m²/ha) giving max. vol. yields in terms of bd ft. From author's summary."

Lyapova, I. 1980. (Growth of Pinus nigra pure and mixed with Tilia tomentosa in young plantations.) Gorkostop. Nauka, 17(4): 23-29. (Bg, ru, en).
From Forestry Abstracts: "Data are tabulated on the performance of Bulgarian plantations of (a) pure pine and (b) mixed pine/linden (50/50, in alternate rows), established in 1974 at a spacing of 1.5x1.0 m. The total aerial phytomass was 38% greater in (b) than in (a), and the above-ground wt. of the average pine plant was 70% greater."

Lynch, T.J. 1980. Thinning and spacing research in Sitka spruce and lodgepole pine. In: Growing space in coniferous crops. Ir. For. 37: 45-67.
From Forestry Abstracts: "The principle results of thinning and spacing studies in the Irish Republic are outlined. Increasing the spacing from 1.8 to 2.4 m square in Sitka spruce results in an overall loss of production of about 4% (more in lodgepole pine) and corresponds to a thinning intensity that removed about 80% of vol. increment over the rotation. The various methods of spacing and thinning are discussed, and a strategy is outlined for accelerated sawlog production by respacing (precommercial thinning) with special reference to lodgepole pine."

Madgwick, H.A.I. 1981. Above-ground dry-matter content of young closely-spaced Pinus radiata stand. N.Z. J. For. Sci. 11(3): 203-209.
From Forestry Abstracts: "DM production was estimated in 5 to 10-yr-old rows of P. radiata planted at a spacing of 1x1.5 m in North Island, New Zealand. The wt. of current (7.8 t/ha) and total foliage (13 t/ha) remained more or less constant with age. Total branch mass increased from 11 t/ha at 5 yr to 36 t/ha at 10 yr, and stem wt. from 52 to 154 t/ha; total above-ground biomass increased from 73 t/ha to 210 t/ha. The m.a.i. culminates at about 10 yr.

Mann, W.F., Jr. 1971. Early yields of slash pine planted on a cutover site at various spacings. USDA, Forest Serv., Southern For. Exp. Sta. Res. Pap. SO-69. 16 pp.
From Forestry Abstracts: "Tabulates basal areas, volumes in cords and ft³, average d.b.h., and diameter distributions at 14 years of age for plantations of Pinus elliottii var. elliottii, of site indices 80-105 (based on height at 50 years), planted at spacings giving 200-2500 trees/acre. The tables are based on analyses of data from 48 plots in a 40-acre plantation in central Louisiana. Various regression equations used are presented."

Mann, W.F., Jr.; Dell, D.R. 1971. Yields of 17-year-old loblolly pine planted on a cutover site of various spacings. USDA, For. Serv., South. For. Exp. Sta. Res. Pap. SO-70. 9 pp.
From Forestry Abstracts: "Tabulates basal areas, volumes in ft³, average d.b.h., and diameter distributions for plots of Pinus taeda, of site indices 70-105 (based on height at 50 years), planted at spacings giving 300-1200 trees/acre. The tables are based on data from 88 plots in an 80-acre plantation in SW Louisiana. The various regression equations used are included."

Mann, W.F., Jr.; Enghardt, H.G. 1972. Growth of planted slash pine under several thinning régimes. USDA, For. Serv., South. For. Exp. Sta. Res. Pap. SO-76. 10 p.
From Forestry Abstracts: "Three intensities of thinning (to b.a. 70, 85 or 100 ft²/acre) were applied at 3-yearly intervals, beginning at 10, 13 or 16 years of age, to 40 plots (including controls) of Pinus elliotti var. elliotti planted at 6x7-ft spacing on a clear-felled site in central Louisiana. Results up to 19 years of age are shown in tables, including data on the cumulative numbers per acre of trees before felling and trees harvested by 1-in d.b.h. classes. Early and heavy thinning increased diameter increment but reduced volume increment. The longer the initial thinnings were deferred, the slower was the response in diameter increment. Growth on unthinned plots was good, and for short pulpwood rotations there might be advantages in leaving stands unthinned.

Mann, W.F. Jr.; Feduccia, D.P. 1977. Tree sizes harvested in different thinnings - another look. USDA, Forest Serv., Southern For. Exp. Sta. Res. Pap. SO-131. 7 pp.
From Forestry Abstracts: "Effects of thinning on saw timber yield were studied in plantations of Pinus taeda and P. elliottii in central Louisiana. Plots in a 20-yr-old stand of P. taeda planted at 10x10-ft spacing were thinned (mainly from below) heavily, moderately or lightly, to a residual b.a. of 70, 85 and 100 ft /acre respectively, at 5-yr intervals up to 45 yr old. Diam. class distributions are tabulated at 30-45 yr old for the residual stand and thinnings, including data for unthinned controls. Similar data are tabulated for 32-yr-old P. elliottii planted at 6x7-ft spacing and thinned at 17, 22 and 27 yr old. In both species the mean diam. of all trees (when thinnings were included in the yield from thinned plots) was highest in controls, which were characterized by the highest number of medium-sized stems. Saw timber yields were highest in lightly-thinned stands, but were spread over a relatively larger number of stems than in controls. It is concluded that management of saw timber plantations without thinning may be economically preferable under certain conditions."

Markovic, J. 1973. (Change in specific gravity of the wood of Populus 'I-214' grown under two régimes differing as regards age and height of the stems.) Topola 17(98/99): 25-33. (Sh, en).
From Forestry Abstracts: "Gives data on the variation in wood sp.gr. across and along the stems in two plantations in Yugoslavia: (a) spacing 6.5x5.63 m, i.e. 278 trees/ha, dimensions at age 12 years being mean diameter 43 cm, mean height 27.9 m and volume 468 m³/ha; and (b) 2.25x2.25 m, i.e. 2000 trees/ha dimensions at age 8 years being 20.5 cm,

20.1 m and 540 m³/ha. The average sp.gr for the whole stem was 312 kg/m³ in (a) and 294 kg/m³ in (b).

Markovic, J. 1974/1975. (The dimensions of wood fibres and the specific gravity of the wood produced by two different silvicultural régimes in relation to age and height in the (Poplar) clone 'I-214'.) Topola 18/19(103/106): 135-150. (Sh, en, ru).
From Forestry Abstracts: "A further report on the trial already noticed which compared wide and close spacings, including data for the dimensions of wood fibres and for branchwood. Second-order regressions of sp.gr. and fibre dimensions on height in the tree were calculated for each annual growth zone in the stem. The equation for the length of wood fibres became linear at 12 years old (decreasing with increasing height in the tree). Stemwood grown at wide spacing was less dense and had longer fibres than stemwood of the same age at close spacing. The sp.gr. of branchwood increased with increasing height of the branch on the stem and was higher than that of stemwood whereas branchwood fibres were considerably smaller than those of stemwood, at the same height in the tree."

Martin, B. 1970. (Afforestation with Pinus caribea on a very poor savanna site at Pointe-Noire.) Cent. Tech. For. Trop. Congo, Pointe-Noire. 22 pp. (Fr).
From Forestry Abstracts: "Describes the establishment, silvicultural treatment and very promising first 10 years of growth of the 4.60-ha plantation of P. caribaea planted at a density of 1000 trees/ha on a poor sandy soil near Pointe-Noire in 1961, and gives (a) single- and (b) double-entre volume tables, based on measurement of the stand in 1969; (a) is for g.b.h. classes 15-19, 20-24, 25-29...85-89 cm and (b) is for the same g.b.h. classes and height classes 6, 7, 8...15 m. The data show that, even under highly unfavourable conditions, the m.a.i. of P. caribaea in Congo-Brazzaville is 10 m³/ha at age 10. Some information is appended on the density, drying and susceptibility to bluestain of Congo-grown P. caribaea wood, obtained from tests on thinnings in another plantation."

Martynov, A.N. 1977. (Intensification of tending of spruce.) Lesn. Khoz. 1: 55-58. (Ru).
From Forestry Abstracts: "The early growth rate of Picea abies is discussed in relation to light conditions, planting density, weeding and thinning to release the Spruce from competing broadleaved species. For 6-year-old plants, the height increment was greatest in plants receiving 63.4% of full light, but plant weight was greatest in plants receiving 100% of full light. In plantation density trials with 100 000 to 820 plants/ha, mean height at 14 and at 18 years was greatest with the lowest planting density. In other trials, early thinning and/or application of herbicides resulted in increased growth of the Spruce at ages 7 and 12 years, and it is concluded that with appropriate management it is possible to bring about a substantial improvement in the growth of P. abies during the early years."

Massinet, S.Du. 1975. (A plea for an unappreciated species. The Japanese larch.) For. Privçe Fr. 102: 101-107. (Fr).
From Forestry Abstracts: "Discusses the valuable properties of wood of Larix leptolepis (especially its dimensional stability and durability) if the trees are grown in properly managed stands, and gives advice on the

correct lay-out and spacing of plantations (2x4 quincuns) and on subsequent silvicultural treatment (with emphasis on frequent heavy thinning)."

Maun, M.M. 1977. Survival and growth of yemane at different spacings. Sylvatrop 2(4): 287-289.
From Forestry Abstracts: "Gmelina arborea trees were planted at: (a) 1.5x1.5 m; (b) 2x2 m; (c) 3x3 m; (d) 1.5x2 m; and (e) 2x3 m. After 10 yr, survival and merchantable and total ht. were n.s.d.; d.b.h. in (c) (15.84 cm) and (e) (14.12 cm) was significantly greater than that in (a) (9.34 cm)."

Maun, M.M.; Sazon, A.C. 1972. Effect of slope and spacing on the survival of Kaatoan Bangkal in Nueva Vizcaya plantation. Philipp., Bur. For., Occas. Pap. 44. 8 pp.
From Forestry Abstracts: "In a study in Magat Experimental Forest, Nueva Vizcaya (Philippines), Anthocephalus cadamba seedlings were planted on areas of abandoned cultivation with slopes of 3.0, 8.5 and 14° respectively, at six different spacings (1x1 m to 4.5x4.5 m) on each site. Twelve months after planting, survival % was not significantly affected by spacing but was adversely affected by the steepest slope, probably because of rapid run-off and inadequate percolation of rainfall."

May, J.T.; Rahman, S.; Worst, R.H. 1973. Effects of site preparation and spacing on planted slash pine. J. For. 71(6): 333-335.
From Forestry Abstracts: "Presents further results of a study previously noticed on Pinus elliottii in Georgia, USA. Measurements made 10 years after planting showed that, in general, site quality, site preparation, spacing and the interactions between the significantly affected height, diameter, total cubic volume and incidence of infection by fusiform rust. The best growth rates, greatest volumes and highest incidence of rust infection were on the better drained sites. Site-preparation treatments that included harrowing increased height and diameter growth and cubic volume on all sites. Incidence of fusiform-rust infection on dominant and codominant trees increased with an increase in spacing, site productivity and intensity of site preparation."

McClurkin, D.C. 1976. Influence of spacing on growth of loblolly pines planted on eroded sites. USDA, Forest Serv., Southern For. Exp. Sta. Res. Note SO-209. 4 pp.
From Forestry Abstracts: "Twenty years after the establishment of Pinus taeda plantations in the Tallahatchie Forest, in N. Mississippi, survival, ht. and diam. growth, and vol., were poorer for trees planted at initial spacings of 4x4 ft than for those planted at 6x6 or 8x8 ft. There was a strong correlation between site index and spacing, suggesting that, for these plantations, ht. and ultimately site index classification were correlated with stocking density rather than with the actual quality of the site. Therefore, for trees planted at close spacings, the use of the ht. of dominant trees as the index of site quality may underestimate potential site productivity."

McKinnel, F.H. 1971. Commercial thinning in radiata pine. For. Dep. West. Aust., Res. Pap. No. 2. 4 pp.
From Forestry Abstracts: "In 1965, plots in an 8-year-old plantation of Pinus radiata (predominant height ca. 60 ft, initial spacing 9x9 ft) on a

site of very good quality near Collie, Western Australia, were thinned to either 300 or 200 stems/acre or were left unthinned at 450 stems/acre. Data are given comparing the effects of the different treatments on the yield and increment of the trees up to an age of 12.6 years."

Mello, H.A.; Coelho, A.S.R.; Netto, A.C.; Simoes, J.W.; Berger, R.; Couto, H.T.Z. 1972. (Influence of species, spacing and age on the production cost of industrial wood.) IPEF 5: 17-28. (Pt, en).
From Forestry Abstracts: "Compares the production cost for unbarked Eucalypt roundwood (per stere and per tonne) for plantations of Eucalyptus saligna, E. alba, E. grandis and E. propinqua planted in Sao Paulo at 3x2 and 3x1.5 m harvested at 5 or 7 years. Production cost depended on species, increasing in the order E. grandis, E. alba, E. saligna and E. propinqua. Costs per stere were lowest for E. grandis at 3x1.5 m, harvested at 7 years. Production cost per stere was slightly less for harvesting at 7 than at 5 years in all species except E. saligna, and was smaller for a spacing of 3x1.5 m than for 3x2 m. Cost per t of dry wood was strongly influenced by the basic density of the species, which was highest in E. alba. The cost per t of dry wood (with an interest rate of 12% p.a.) was lowest with E. alba at both spacings, harvested at 7 years. With a 5% interest rate, in all the species the cost per t was lower with the closer spacing and the longer rotation."

Mello, H.A.; Mascarenhas Sobrinho, J.; Simoes, J.W.; Couto, H.T.Z. Do. 1970. (The effects of mineral fertilizers on the yield of timber of Eucalyptus saligna on 'cerrado' soils in the state of São Paulo.) IPEF 1: 7-26. (Pt, en).
From Forestry Abstracts: "Describes an experiment in which N, P, K, and Ca were applied, individually or in combination, to E. saligna at the time of planting out (spacing 3x1.5 m) on a red-yellow lateritic soil (sandy phase) in the municipality of Mogi Guacu, N, as $(NH_4)_2SO_4$, was applied at rates equivalent to 0, 30, and 60 kg/ha of N; P, as P_2O_5, at 0, 40, and 80 kg/ha; K, as K_2O, at 0, 50 and 100 kg/ha; and lime was broadcast at 0 and 2 t/ha. The trees were felled at age 5 years, and the yield of barked timber was recorded. With P_2O_5 there were significant differences at the 1% level between the 0- and 40-kg treatments, and at the 5% level between the 40- and 80-kg treatments. There was also an interaction between N and Ca, significant at the 5% level. The fertilizers had no adverse effects on the suitability of the wood for pulping. It is estimated that, for the conditions of the experiment, treatment with 53 kg N, 172 kg P_2O_5 and 25 kg K_2O at the time of planting out can be recommended."

Mello, H.A.; Simoes, J.W.; Ferreira, C.A.; Brasil, U.M. 1976. (The effect of spacing and age of felling on the production of wood of eucalypts grown on 'cerrado' soil.) IPEF 13: 143-162. (Pt, en).
From Forestry Abstracts: "Results are given of a study of the effects of two different spacings (3.0x1.5 and 3.0x2.0 m) and ages of felling (7 and 9 years) on the volume and weight of pulpwood produced by plantations of Eucalyptus urophylla, E. saligna, E. grandis and E. propinqua grown on 'cerrado' soil (a poor but deep acid sandy latosol) in São Paulo. Yields were not significantly affected by spacing. The most productive species in terms of wood volume, average increment and weight per ha, irrespective of

age of felling, was E. urophylla, with yields of 305.71 and 417.27 steres/ha at 7 and 9 years of age respectively."

Mello, H.A.; Simoes, J.W.; Mascarenhas Sobrinho, J.; Couto, H.T.Z. Do. 1971. (The influence of spacing on wood production by Eucalypts in a 'cerrado' soil.) IPEF 2/3: 3-30. (Pt, en).
From Forestry Abstracts: "Trial plots of Eucalyptus saligna, E. grandis, E. alba and E. propinqua were established on a poor, acid 'cerrado' soil in the Horto 'Santa Terezinha' (Property of Champion Celulose S.A.) in Mogi-Guaçu, Sao Paulo (long. 47°07'W., lat. 22°11'S., altitude 580 m) at intial spacings of 3x1.5 and 3x2 m. The results are presented of fellings at age 5 years; later fellings of other plots at age 7, 9 and 11 are envisaged. There was a significant difference at the 1% level between the yield in steres/ha (barked wood) of E. propinqua, which gave the lowest yield, and the other three species, where the differences were comparatively small. The over-all average yield for the 3x2-m plots was 234.31, and for the 3x1.5-m plots, 219.23 steres/ha. E. saligna seemed to be the most suitable species for the conditons of the experiment; at the 3x2-m spacing it yielded 268.25 steres/ha or, expressed as dry weight, 93.14 tons/ha. Except for E. alba, yield in steres/ha was higher with the 3x2-m spacing. Dry-weight yield per ha was higher for all four species with the wider spacing, which is recommended for these species (in the conditions of the experiment) for short-term production of wood for industrial purposes."

Mendoza, V.B.; Glori, A.V. 1976. Fertilization of yemane (Gmelina arborea) in Carranglan, Nueva Ecija. Sylvatrop 1(2): 138-141.
From Forestry Abstracts: "Six-month old bare-rooted seedlings were planted at 2x2 m spacing and NPK was applied one month later at (a) 50, (b) 100, and (c) 150 kg/acre, or (d) untreated control. A second application of NPK was made one year later and grasses and weeds were slashed every 4 months. Ht., diam. and survival were recorded every 6 months. In (b), diam. was 109% and ht. 80% greater than in (d) but there was no significant further increase in (c); (a) did not significantly improve diam. or ht. Survival was slightly less in (d) than (a), (b) or (c)."

Ménétrier, J. 1978. (Research and development work on poplars in eastern Quebec. XI. Wood production in dense plantations.) Serv. Rech. For. Québec, Mém. 44. xiii+35 pp. (Fr, en).
From Forestry Abstracts: "In trials near Kamouraska (47°40'N., 68°59'W), production is compared of (a) 'B-201-B' (P. deltoides 'Angulata' (P. angulata) x P. trichocarpa) and (b) P. 'Q-36-Q' (P. x euramericana (P. x canadensis aggr.)) grown at spacings of 0.3x1.2 m and 0.6x1.2 m with or without cutting back at 1 yr old. Fertilizer was applied in the 1st and 2nd yr to give a total dosage (in kg/ha) of 185 N, 81 P and 47 K. Max. av. DM production was 5.1 t/ha/yr for (a) on a 3-4-yr rotation without cutting back."

Merzlenko, M.D. 1974. (K.F. Tyurmer's spruce plantations on the Smolensk/Moscow uplands.) Lesn. Zh. 17(2): 15-18. (Ru).
From Forestry Abstracts: "Gives details of an inventory of various plantations of pure Picea abies established late in the 19th century on an Oxalis site type at planting densities ranging from 1462 to 4000 trees/ha. The stands were 67-89 years old at the time of the inventory (in 1969).

The best stand was one established at a planting density of 2500 trees/ha; this now has a standing volume of 637 m^3/ha at 67 years of age. In general, the standing volume of the older plantations is substantially greater than that of natural Spruce stands aged 90 years in the Moscow region."

Meskimen, G.; Franklin, E.C. 1978. Spacing Eucalyptus grandis in southern Florida. A question of merchantable versus total volume. South. J. Appl. For. 2(1): 3-5.
From Forestry Abstracts: "E. grandis was planted in August 1964 at spacings of 4x8, 8x8, 12x8 and 16x8 ft. After 7 years the vol. in merchantable trees (4 inches d.b.h. and larger) did not significantly differ between the spacings. Merchantable yields could therefore be obtained from the wider spacings at lower cost for establishment and harvest. Total vol. in all stems was 1.7 times greater at the closest spacing than at the two widest spacings. By chipping small trees in the field, vol. yields 16-68% greater could be achieved by planting at close spacings. Neither wood quality nor tree ht. was significantly affected by stand density over the range of spacings tested."

Meyer, R. 1975. (The use of large planting stock in the reforestation of windthrow sites.) Forst- und Holzwirt 30(4): 68-70. (De).
From Forestry Abstracts: "Briefly describes a method successfully developed since 1963 in a NW German forest department, in which whole rows of various conifers are lifted from closely spaced plantations (1.5x1 or x 1.5 m) nearby and are planted immediately, at wide spacing, in prepared planting holes on uncleared windthrow sites. Stock 60-80 cm tall, or in tall weeds 80-100 cm tall, is planted in spring or late summer. Planting costs are higher, but the closely spaced stands are thinned, site-clearing costs (and mostly also costs of weeding) are saved, the valuable nutrients and protective functions of the slash are preserved, and browsing by deer is much reduced. Recommended planting times are given for large planting stock of Spruce, Larch, and Fir species, Scots Pine and Douglas Fir."

Mitchell, K.J. 1978. Impact of planting density and juvenile spacing on the yield of Douglas-fir (Pseudotsuga menziezii). Pages 143-158 in Growth models for long term forecasting of timber yields. USA, Blacksburg, Virginia, School. For. Wildlife Resour.

Mitirev, A.E.; Sablin, A.F. 1976. (Effect of thinning on the growth and development of the stand.) Lesn. Khoz. 5: 34-36. (Ru).
From Forestry Abstracts: "Gives results of thinning trials in pure plantations of Pinus sylvestris established in 1936 on sandy loam soils, with a spacing of 0.5-0.7 m on the rows. In 1962 thinnings were made removing 10, 13, 15, 20, 25, 30, 35, 40 and 50% of the standing volume. Data are tabulated on tree numbers, dimensions and increment in the various thinning treatments in 1969 and 1974, and on the distribution of the standing volume by size classes and assortments. The results are discussed, and it is concluded that the optimum thinning in a stand of density 1.0 on B_2 sites (fairly moist and poor soils) is one which removes 20-30% of the standing volume. To produce large assortments more quickly, a thinning of 35-40% is recommended."

Molino, O. 1972. (Yield from pines planted at different initial spacings.) Asoc. Plant. For. Misiones, Bol. 7: 61-66. (Es).
From Forestry Abstracts: "Trials with Pinus elliottii var. elliottii, P. caribaea var. caribaea, P. caribaea var. hondurensis and P. patula planted at spacings of 2x2, 2x2.5, 2.5x2.5, 3x2 and 3x3 m were established in 1960 in an arboretum of Celulosa Argentina, Piray, Misiones. The 2x2-m spacing gave the greatest volume increment for all species except P. patula, which yielded more at the 3x3-m spacing. In general, the latter spacing produced a greater proportion of trees in the higher diameter classes. Brief notes are included on a number of other exotic conifers.

Molino, O. 1978. (Yield of resiniferous pines at different planting distances.) Pages 1850-1854 in: Proc. of the Seventh World For. Cong., Buenos Aires, Argentina, 4-18 Oct. 1972. (Es, en, fr).

Moller, C.M. 1973. (The assessment of the economics of plant spacing.) Dan. Skovforen. Tidsskr. 58(1): 65-71. (Da).
From Forestry Abstracts: "Discusses, with example, the effects of various factors (viz. species, site class, costs and prices) that should be taken into account when assessing optimum economic spacing, with special reference to the spacing of Picea spp. in Denmark."

Montagna, R.G.; Kronka, F.J.N.; Mainieri, C.; Dias, R.A.; Kronka, S.N. 1973. (Study of the growth and density of the wood of Pinus elliottii as a function of spacing.) Silvic. em São Paulo 8: 33-52. (Pt, en).
From Forestry Abstracts: "Describes the results of trials with six different spacings ranging from 1.5x1.0 to 3.0x3.0 m in a plantation at Casa Branca, São Paulo, assessed five times between 1960 and 1970. At the end of that period it was 16 years old. Significant differences in mean diameter increment occurred between the two extremes of spacing. The two extremes produced a slight reduction in basic density and an increase in maximum moisture content in comparison with a spacing of 2.0x1.5 m. A general description of the wood and its anatomy, and measurement of tracheid dimensions in early and late wood are analysed statistically (without consideration of any effects of spacing)."

Moore, D.G. 1973. The oceanic forest: a study in profitability. Scott. For. 27(2): 93-102.
From Forestry Abstracts: "Puts forward the view that the traditional method of growing conifers in Britain (here referred to as 'the continental system'), in which trees are grown at high density, is completely unsuited to the oceanic climate and the relatively fertile marginal lands available for afforestation in this country, and advocates its replacement by a method, which the author calls 'the oceanic system', of growing trees at wider spacing with selection of crop trees just before closure of the canopy. Tending measures should be directed towards the maintenance of adequate crown depth and uniformity of ring width throughout the stem and throughout the rotation."

Morrow, R.R. 1974. Stem form and radial growth of red pine after thinning. North. Logger 22(10): 20, 21, 44.
From Forestry Abstracts: "In a thinning trial in stands planted at a spacing of 6x6 ft in New York in 1940, three treatments were compared: (1)

unthinned, 900 trees/acre after 33 growing seasons; (2) normal thinning, i.e. reduction to 500 trees/acre by thinning at ages 19 and 22 years; and (3) early wide spacing, removing alternate rows at age 12 and more trees at 14, to leave 350 trees/acre. Stem analyses were made of trees equivalent to crop trees in each treatment, to determine changes in stem form and radial growth after thinning. Height growth appeared unaffected by thinning, and radial growth followed expected patterns, being higher throughout the tree after thinning, declining with age, and usually increasing with tree height above b.h. Form class increased with age, and there was little difference between (1) and (2), but treatment (3) markedly influenced form. Results are compared with those found by Berry (see FA 27, 5943). The relatively short-lived affect of (3) was surprising; this treatment lengthened the period of large juvenile growth rings, but the crowns closed quickly and growth slowed to >10 rings per inch at b.h. by age 23. Treatment (3) can reduce costs but is no substitute for timely thinnings."

Morrow, R.R. 1978. Growth of European larch at five spacings. N.Y. Food Life Sci. Bull. No. 75, 11 p.
From Forestry Abstracts: "Results up to 25 yr after planting 2+0 stock in southern New York State (stand remained unthinned) are discussed in relation to: survival; ht.; crown depth; diam. growth; b.a. growth; upper stem radial growth; stem form; branch diam.; tree quality and timber use; and ground cover, litter depth, and invading broadleaves. The major permanent effect of initial spacing was on size of the core of juvenile wood. A spacing of 10x10 ft is recommended for suitable growth, economical thinnings, and suitability for a wide variety of wood products."

Mráček, Z. 1970. (Trial plot established to examine the effect of spacing on stand quality.) Lesnictvi 16(6): 513-523. (Cs, ru, en, de, fr).
From Forestry Abstracts: "A report confirming conclusions already reached tentatively in Norway Spruce spacing trails (cf. FA 30 No. 3931; 31 Nos. 2477, 6338): (1) even with a range of variation of initial spacing of 2500-10 000 plants/ha, spacing is by no means the only factor governing stand quality; (2) for Czechoslovakia, medium spacing (1.5x1.5 m or 4444 plants/ha) is recommended."

Mráček, Z. 1980. (Stability of young Norway spruce stands in relation to their growing space.) Schr. Forstl. Faleultät, Univ. Göttingen/Niedersachs. Forstl. Versuchsanst. 67: 247-259. (De, en, fr).
From Forestry Abstracts: "Snow damage in 1978 to a spacing experiment established in western Bohemia in 1965 showed that stability increased with wider spacing: opt. spacing was 2x2 m."

Mrazek, F. 1979. (The effect of planting stock size on the growth and economics of Scots pine plantations.) Beitr. fur die Forstwirt. 13(2): 51-53. (De, ru, en).
From Forestry Abstracts: "A 6.7-ha area on a medium site in E. Germany was planted in spring 1974 at 12 500-15 625 stems/ha with stock of 3 sizes: (a) 1+0 bare-root stock (shoot length 2.7 cm); (b) 2+0 Nisula stock (7.1 cm); and (c) 1+2 Nisula stock (27.0 cm). Mean ht. was measured annually up to 5 yr old. Because (c) required no weeding, total establishment costs were only slightly higher than for (a) and lower than for (b),

and growth was considerably better in (b) and (c) than in (a) which had not yet reached establishment."

Mugasha, A.G. 1978a. Preliminary results on the performance of Cinnamomum camphora Nees from a tree increment plot in Tanzania. Tanzania Silvic. Tech. Note No. 37, 8 pp.
From Forestry Abstracts: "A 0.16-ha increment plot was laid out in a 24-yr-old plantation in Kitivo Forest Reserve in 1967, and assessments of mean d.b.h. and dominant ht., growth rate and yield were made up to 1977. Thinnings were carried out in 1968, 1972 and 1977 (initial density 752 stems/ha; final density 360 stems/ha). In 1977, mean dominant ht. was 29.4 m (m.a.i. about 0.9 m) and mean d.b.h. 34.7 cm (m.a.i. about 1 cm). D.b.h. increment was low compared to results obtained in India, but the growth rate compared favourably with other broadleaves planted in Tanzania. A tendency to form double leaders at 14-17 m ht. was probably due to the heavy thinning."

Mugasha, A.G. 1978b. Some effects of heavy thinning on the growth of Ocotea usambarensis Engl. at Barankata, Kilimanjaro region. Tanzania Silvic. Tech. Note No. 38, 9 pp.
From Forestry Abstracts: "Two well-stocked plots of naturally-regenerated O. usambarensis about 17 yr old at Barankata, Tanzania, were assessed for diam. and ht. from 1958 to 1977. One plot (initially 786 stems/ha) was cleared of weeds and 5 thinnings were carried out (finally 221 stems/ha). In the other plot (940 stems/ha), old malformed trees were poisoned at the beginning of the experimental period, but no artificial thinning was carried out (604 live stems/ha in 1977). Thinning significantly increased diam. growth and could reduce the theoretical rotation age from 60-70 yr to 50 yr (though with possible adverse effects on wood quality)."

Mühle, O.; Huss, J. 1972. (The effect of weed-control operations and their timing on the growth of young Norway Spruce.) Allg. Forst.- Jagdztg. 143(12): 253-260. (De, en, fr).
From Forestry Abstracts: "Plantings were made of 1+2 Picea abies, spaced 0.5x0.5 m, on sites uniformly covered with dense Deschampsia flexuosa (a), Calamagrostis epigeios (b) or Pteridium aquilinum (c). Plots were weeded once or twice annually during the first three growing seasons by mowing with a sickle at different dates, and in one series of the trials herbicides (dalapon for the grasses and Prefix for the bracken) were applied. Biomass production of (a) was reduced only by herbicidal treatment, but that of (b) was significantly reduced by mowing, cutting in Aug. being more effective than cutting in June. Satisfactory control of (c) resulted from cutting in July and Aug., cutting in June having little effect. The effect of the treatments on the mortality, height, weight and diameter growth of the Spruce was small except in (c)."

Mühle, O. Kappich, I. 1979. (First results of a beech provenance and spacing experiment in the Bramwald forest district.) Forstarchiv 50(4): 65-69. (De, en).
From Forestry Abstracts: "The trial was established in 1963 with 2+2 plants of beech (Fagus sylvatica) on a beech forest site N. of Hann. Münden. Five W. German provenances were planted, each at 2-4 spacings (1.0-1.3x0.5-1.3 m) but without replication. Ht., d.b.h., stem form and crown form were measured in 1978. Survival decreased with increasing

planting density, being 80-90% at 1.3x1.2 m and 70% at 1.3x0.5 m. D.b.h. decreased with increasing planting density, but ht. was not affected. The quality of the stems was better at the higher planting densities. There was little difference between the provenances."

Mülder, D. 1979. (Between genetics and secateurs: decisions on the treatment of crooked growth in larch.) Forstarchiv 50(7/8): 145-148. (De).
From Forestry Abstracts: "The problem of crooked growth in larch (Larix decidua) is discussed on the basis of surveys in different parts of W. Germany. The causes are mainly environmental, such as wind and game damage. It is recommended that plantations be established with close spacings (2.0x2.5 or 2.5x3.0 m), combined with early cleaning (at 2-4 m tall) to remove crooked stems. Fencing of plantations is particularly recommended; in this case, a spacing of 3.0x3.0 m is suggested. Crooked growth can be remedied by cutting back, but only in the early stages of growth."

Murphey, W.K.; Bowersox, T.W.; Holt, D.H.; Blankenhorn, P.R.; Baldwin, R.C. 1977. Selected wood properties of young hybrid poplar (clones NE-49, NE-252, NE-388 planted at different densities.) In TAPPI Conf. Papers. For. Biol., Wood Chem. Conf. Madison, Wis., June 22-27, 1977.

Naĭdenova-Yaneva, T. 1973. (Growth and yield of Populus deltoides in relation to hoeing in the first few years.) Gorskostop. Nauka 10(6): 33-40. (Bg, ru, en).
From Forestry Abstracts: "Plantations in Bulgaria, established at spacings of 2x2 to 6x6 m on alluvial soil, were hoed 0, 1, 2, or 3 times a year during the growing season for the first four years. Data are given on survival and growth of the plantations up to 13 years. At all spacings, survival and increment were greatest in the plots that were hoed three times per season. Depending on spacing, the total growing stock on plots given three hoeings exceeded that on unhoed plots by 164.9-278.1 m^3/ha."

Neary, D.G.; Day, M.W.; Scheider, G. 1974. Snow damage to branches of young red pine stands related to plantation density. Can. J. For. Res. 4(1): 91-96. (En, fr).
From Forestry Abstracts: "Snow damage was measured in 1972 in a 9-year-old P. resinosa plantation in N. Michigan after three severe winters. Damage attributable to snow was usually in the form of complete branch breakage or partially severed lateral branches. Plantations with 2000 trees/ha suffered 3-4 times more damage than those with 500/ha. Injury was primarily concentrated at ca. 75 cm above the ground, a height reflecting snow depth. This corresponded to the location of the fourth whorl, where branch injury was twice as extensive in plots with 1000, 1500 or 2000 trees/ha as in those with 500 or 750/ha. Few trees have yet (1973) died from their injuries, but many have been weakened and are thus predisposed to attack by pests and diseases and to further mechanical injury."

Nekhaĭchuk, O.G.; Bobrov, A.I.; Bryantseva, Z.E.; Treivmanis, A.P.; Purina, L.T.; Konareva, V.N. 1982. (Influence of growth conditions on the properties of early and late wood of Larix sibirica and of the wood pulp.) Khim. Drevesiny 1: 25-30. (Ru).
From Forestry Abstracts: "A more detailed version of studies on the wood

and pulping properties of 20-yr-old larch in the plantation spacing trial (near Moscow) already noticed. The present version emphasizes that the wood grown at wide spacing had a lower % latewood and a lower density than the wood grown at close spacing (i.e., larch did not differ from other conifers in this respect)."

Nekhaĭchuk, O.G.; Moskaleva, V.E. 1979. (Effect of forestry factors on the anatomical structure of the wood of spruce, pine and larch.) Lesovedenie 4: 38-43. (Ru, en).
From Forestry Abstracts: "Investigations were made on the effect of wide and close spacing on the quality of the wood produced by Picea abies, Pinus sylvestris and Larix sibirica. The plantations had been established in 1959 at densities of 1800 plants/ha (spacing 4.5x1.2 m) and 5600 plants/ha (spacing 1.5x1.2 m). Data are tabulated on yield and wood properties at age 20 yr. The yield/ha was the same with the wide and close spacings. Ring width, tracheid length and lumen diam., and, in the spruce and pine, the % of earlywood, were all greater at the wider spacing, as was the strength of sulphate pulps prepared from the woods. Tracheid wall thickness was smaller at the wider spacing. In trees grown at the wider spacing, the wood consisted mainly of early tracheids, identical in structure and composition, making it ideal for certain types of paper requiring uniform fibres."

Nelson, N.D.; Burk, T.; Isebrands, J.G. 1981. Crown architecture of short-rotation, intensively cultured Populus 1. Effects of clone and spacing on first order branch charateristics. (AN. J. For. Res. 11(1): 73-81. (En, fr).
From Forestry Abstracts: "Branch characteristics including number, length and diam. of branches and their angles of origin and termination were quantified for nine 4-yr-old Populus clones grown at 3 square spacings (0.3 0.6 and 1.2 m). Clone and spacing had statistically significant effects on all branch characteristics, but there was no significant clone/spacing interaction for any branch characteristic. As spacing increased, the number, sum of lengths and angle of origin increased, but the angle of termination decreased. Length and diam. were highly correlated within all clones. The two clones with the smallest angle of origin had the smallest angle of termination and the clone with the greatest angle of origin had the greatest angle of termination, but correlation was low when all clones were considered. The fastest-growing clones are recommended for further growth trials, those with large branch-angles for wide spacing and those with small branch-angles for close spacing."

Netrebenko, V.G.; Naumenko, G.A. 1976. (Platanus acerifolia in shelterbelts.) Lesn. Khoz. 9: 45-46. (Ru).
From Forestry Abstracts: "An account of experience with P. acerifolia near Odessa (S. Ukraine) where a shelterbelt was established in 1971, with P. acerifolia as the main species, with some Walnut and Privet. The planting was done by machine, with a density equivalent to 2300 Plane, 300 Walnut and 1250 Privet plants per ha. Details are given of the tending, survival and growth of the belt, and data are tabulated on tree and crown dimensions up to 4 years. In general, growth of P. acerifolia has been quite good, with height m.a.i. 52 cm and diameter m.a.i. more than 0.5 cm. At the spacing used, 2.5x1.0 m, crown closure is almost complete within the rows at age 4, but not between the rows. No frost damage to the leading buds

has been observed, and the trial indicates that P. acerifolia is a promising species meriting further trial for shelterbelts in this region."

Nikolov, S.; Kostov, K.D.; Bl"skova, G. 1979. (The effect of the density and arrangement of trees on the anatomical structure and physical and mechanical properties of wood of Pinus nigra.) Gorskostop. Nauka 16(5): 80-89. (Bg, ru, en).
From Forestry Abstracts: "Wood samples were taken at b.h. from trees in plantations 21 and 22 yr old in Bulgaria, established at spacings of 1x1 m and 1x1.5 m, and trees were also sampled from the outermost northern margin of a plantation established at 1.2x1.2 m. Data are presented on the dimensions of the trees, ring width, latewood %, dimensions of tracheids, rays and resin canals, and the physical and mechanical properties of the wood. There were some significant differences in wood anatomy between the spacings, but the wood properties of the closely-spaced trees were satisfactory."

Nogami, K. 1974. (Study on the effects of fertilizer applied to the forest land.) Bull. Kyushu Univ. For. 48: 1-111. (Ja, en).
From Forestry Abstracts: "Describes and presents results of laboratory and field studies on the uptake and release of N, P and K, infertilizer trials with seedlings and in 11-year-old stands of Chamaecyparis obtusa, planted at various spacings. Investigations are included of the effects of various soil types on the rate of fertilizer uptake, and of the effects of spacing and fertilizer treatment on CO_2 fixation by needles. The salient results are given in the 5-page English summary."

Nogueira, J.C.B.; Siqueira, A.C.M.F. 1976. (Spacing trial with Tabebuia vellosoi.) Silvic. São Paulo. 10: 55-59. (Pt, en).
From Forestry Abstracts: "The trial was established at Pederneiras Experiment Station in 1964. The spacings used were 1x1, 1.5x1.5, 2x2, 2.5x2.5 and 3x3 m. Under the local climatic conditions the best spacing, as shown by height measurements in 1976, was 2.5x2.5 m.

Nostrand, R.S. van. 1975. Preliminary assessment of planted spacing trials in Newfoundland. Newfoundland For. Res. Cent. Inf. Rep. N-X-133. 14 pp.
From Forestry Abstracts: "Picea mariana, P. sitchensis and Abies balsamea were planted in three trials to test the effects of spacing and of the application of slow-release NPKCaFe fertilizer in the planting hole at planting time; Nelder's 1962 circular-plot design (which provides for comparison of 8 treatments, with plants arrayed along 48 'spokes' - cf. Biometrics 18, 282-307) was used. After four growing seasons, the results of these tests showed no growth trends attributable to differences in spacing, but there was a small over-all positive response to the fertilizer."

O'Brien, D. 1980. Economics of spacing, respacing and thinning. In: Growing space in coniferous crops. Irish For. 37(2, Suppl.): 77-96.
From Forestry Abstracts: "An economic evaluation is presented of a number of silvicultural treatments including spacing, respacing and thinning in Sitka spruce and coastal lodgepole pine stands in the Irish Republic. The results show, for the two prices assumed, that lower crop densities than

those now practised lead to greater profitability if wood quality is not drastically reduced. From author's summary."

O'Flanagan, L.P. 1980. Lodgepole pine - silvicultural alternatives. In: Growing space in coniferous crops. Irish For. 37(2, suppl.): 68-76.
From Forestry Abstracts: "Costs were estimated of 3 silvicultural options for a 9-yr-old stand established at 2x1.5 m spacing on deep peat (raised bog) in Loch Ennel forest, Irish Republic: (a) normal practice as envisaged in standard yield tables with high pruning (to 6 m) of 400 stems/ha; (b) immediate respacement to 800 stems/ha with high pruning up to 17 yr old, and clear felling at 35 yr old; and (c) a non-thinning regime with rotations of 30, 40 or 50 yr. Option (b) gave the best net discounted revenue at all interest rates (2-10%). Respacement was done at this site with urea treatment of all stumps (against Fomes annosus (Heterobasidion annosum); all debris was left on site."

Oliver, W.W. 1979. Early response of ponderosa pine to spacing and brush: observations on a 12-year-old plantation (in North California.) USDA, Forest Serv., Pac. Southwest For. Range Exp. Sta. Res. Note PSW-341. 7 pp.

Onis'kiv, N.I. 1972. (The importance of the row alignment in the success of plantations under canopy.) Nauch. Tr. Ukr. S-kh. Akad., No. 65, Pp. 104-107. (Ru).
From Forestry Abstracts: "Observations for 4 years on plantations of Quercus robur and Q. rubra established under the canopy of Scots pine stands in the Kiev region of the Ukraine showed that survival and growth were better in rows aligned NW-SE and NE-SW than in rows aligned E.-W. and N.-S."

Oosterbaan, A. 1981. (Development of young stands of Quercus robur in the Vaals forest district.) Ned. Bosbouw Tijdschr. 53(6): 165-172. (Nl, en).
From Forestry Abstracts: "Nine oak stands established in the early 1940s (chiefly by planting unknown provenances at 1.25x1.25 m spacing) on flint-loam alluvial soils in S. Limburg, Netherlands, were measured in 1964, 1971 and 1980 and also (in 1980) evaluated for natural pruning, stem quality and understorey growth. Stand growth corresponded to the English yield tables (site quality I-II) and was better on slopes (vegetation type Querceto-Carpinetum) than on higher ground (Querceto-Betuletum). Stem quality was also good; top-ht. trees (ht. 14-19 m) had pruned themselves to 30-50% of their ht., but stubs remaining on future crop trees suggest that pruning might be desirable. The naturally developed understorey may not be sufficiently fast-growing to suppress epicormics."

Orlic, S. 1971. (Pruning in intensively managed Scots pine plantations.) Sum. List, 95(1/2): 18-25. (Sh, en).
From Forestry Abstracts: "Gives preliminary results of a trial in a plantation established at a spacing of 2x2 m in 1962 in Yugoslavia. In spring 1966, trees were pruned to remove 20 to 30% of the live crown. Measurements in autumn 1966 and 1969 revealed no significant differences in height and diameter increment between the two treatments and unpruned controls. It is provisionally concluded that Scots Pine plantations may be

pruned to remove 30% of the live crown at about the time of canopy closure."

Orlic, S. 1973. (Comparative investigation on optimum spacing of Pinus sylvestris and P. strobus in intensive plantations.) Summary List 11/12: 421-431. (Sh, en).
From Forestry Abstracts: "Gives preliminary results of a spacing trial started in Croatia in 1966, in which P. sylvestris was planted in the spring on a pseudogley site and P. strobus in the autumn on a lessivé terra rossa site, both at five different square spacings from 1x1 m to 3x3. In autumn 1969, total height and length and diameter of the 1969 leader were measured. The results are tabulated, and indicate that the wider spacings (2x2 m and 3x3 m) appear to be preferable to the closer ones."

Orlova, N.A. 1973. (Growth and yield of hybrid poplars in the town of Frunze.) Pages 30-35 in Kul'tura lesnykh porod v kirgizii. Frunze, USSR. Pp. 30-35. (Ru).
From Forestry Abstracts: "Tabulates data on the height, d.b.h., and m.a.i. in height, and wood volume (in m³ at a density of 2500 plants/ha) at 5 years for 85 clones in irrigated plantations at Frunze, Kirghizia. The 25 best-yielding clones are determined, and also the poorest clones, the clones with best form, and the clones that have started flowering. The close spacing (2x2 m) is already resulting in reduced increment, and a 50% thinning is recommended."

Osterhaus, C.A.; Lantz, C.W. 1978. Pine plantations on the Cross Timbers area of Oklahoma. South. J. Appl. For. 2(3): 90-93.
From Forestry Abstracts: "The first stage of a study in east central Oklahoma, to determine whether a non-commercial low quality broadleaf area (primarily Quercus stellata, Q. marilandica, and Carya spp.) can be successfully planted with pine. Sites were prepared by aerial spraying (2,4,5-T and picloram, in 1970) and prescribed burning (1972 and 1973), and 1+0 seedlings of Pinus taeda, P. echinata (local provenances), P. virginiana (Alabama), P. pinaster (W. Europe) and P. brutia (Turkey) were planted in 1973 and 1974 at 6x8 ft spacing in 0.1-acre plots. Data for survival and ht. up to the end of 1974 show that P. taeda, P. echinata and P. virginiana established well and were superior to the other 2 species, especially under conditions of high rainfall (1973). Short-rotation pines are suggested as a land-use alternative for this area."

Oswald, H. 1980. (A spacing trial with grand fir (Abies grandis).) Rev. For. Fr. 32(1): 60-76. (Fr).
From Forestry Abstracts: "Results are presented of the trial, established with 1+2 plants at Amance, France, after 20 yr of observation. The spacing regimes were: (a) 2x2 m (2500 plants/ha); (b) 2.5x2.5 (1600/ha); (c) 3x3 (1111/ha); (d) 3.5x3.5 (816/ha). The plantation was made under the cover of a former coppice with standards which was removed progressively over 7 yr. There was n.s.d. between the spacing regimes for mortality and mean ht., but dominant ht. was shown to be less in d than in a. Girth increased, whereas total stem vol., b.a., and the coefficient of form, i.e. vol. (ht.xb.a.) decreased, with increased spacing. Values for total stem vol. 20 yr after planting relative to a were: b = 79%, c = 65%, d = 50%. Mean stem vol. varied in the opposite way (109%, 135% and 134%). The results are compared with those from a spacing trial in the same region

using Douglas fir and with a British production table for A. grandis."

Oswald, H.; Pardé, J. 1976. (A spacing experiment in planting Douglas fir in the state forest of Amance.) Rev. For. Fr. 28(3): 185-192. (Fr).
From Forestry Abstracts: "A Pseudotsuga menziesii trial laid out in 1955 and assessed in 1966 and 1970 was reassessed in 1973, before any thinning. It is concluded in general terms that a spacing of 1.5x1.5 m is wasteful; that 2x2 m would only be justified in the case of whole-tree harvesting on a short rotation; that 2.5x2.5 m is about right, giving good stability and reasonable natural pruning; and that 3x3 m leads to excessive cost for cleaning and pruning as well as to losses in production (20-30% at 18-20 years). The plots have now been used for thinning experiments. For each initial spacing, four thinning regimes are under trial: (I) nil, (II) once-only removal of every second diagonal row, (III) as for II, but to be followed up in a way yet to be defined, and (IV) designation of crop trees at 250/ha (= 25/plot) and a heavy selective thinning, also to be followed up. The first thinnings were done in 1973/74. Severe storms in February 1974 and autumn 1974 have already produced indications that line thinnings leave the stand vulnerable, whereas even a heavy traditional thinning leaves it stable. There was no damage at all in the unthinned plots. The densely planted stands were much more affected than the open ones. Data are tabulated for the stem numbers and volumes before and after thinning and for the stem numbers removed by the storms."

Ovcharov, G. 1975. (Effect of plant spacing on the yield of Scots pine stands.) Gorsko Stoparstvo. 31(11): 10-15. (Bg).
From Forestry Abstracts: "Bulgarian data on the yield of Pinus sylvestris in relation to plant spacing (number of trees per ha) are presented for a number of stands of various ages in the Yundola forest district. The findings are compared with data from the Tyurin, Schwappach and Ukrainian yield tables. Results indicate that the optimum density for stands of P. sylvestris is in fact ca. 30% greater than that shown in Tyurin's yield tables."

Palashev, I.; Manolova, L.; Nikolov, V. 1973. (Growth and yield of Populus deltoides at different spacings on sites away from the rivers in the NE part of the Thrace/Tundzha poplar region.) Gorkostop. Nauka 10(1): 35-43. (Bg, ru, en).
From Forestry Abstracts: "Gives details of the performance up to age 12 years of plantations established at spacings of 2x2, 3x3, 4x4, 5x5, and 6x6 in SE Bulgaria. Stemwood volume per ha at age 12 decreased with increasing spacing, and m.a.i. (stemwood volume) was only 4.84 m^3/ha at the 2x2-m spacing, falling to 2.38 m^3/ha for the 6x6-m spacing. It is concluded that these sites, away from the typical riverside Poplar- growing areas, are unsuitable for Poplars, and existing plantations should be harvested at age 10 years."

Palit, S. 1980. Trials of Albizia faleataria (L.) Fosberg and Leucaena leucocephala (Lam.) DeWit in North Bengal. Indian For. 106(7): 456-465. (En, hindi).
From Forestry Abstracts: "The production performance, natural enemies and uses of (a) A. falcataria and (b) L. leucocephala are described based on trials in N. Bengal: (a) showed the potential to produce 40 m^3/ha annually

at 3-5 yr old assuming 50% survival and establishment at 2x2 m, and (b) produced the equivalent of an annual 30-40 m³/ha over 4 months. Insect and browsing damage appear to be a problem with both species. Both have potential in social forestry for fuelwood production and (b) for fodder production. Approx. areas necessary to provide a family with fuel are calculated from the preliminary production data."

Pan, C.S. 1974. (Rainfall interception in (1) a Eucalyptus robusta plantation: (2) Cunninghamia lanceolata plantations with different degrees of thinning; (3) Calocedrus (Libocedrus) formosana plantations with different spacings.)) Taiwan For. Res. Inst., Bull. No. 253; 255-256; 8 p+12 p+11 p. (Ch).
From Forestry Abstracts: "Reports measurements made at Lien-Hwa-Chih experiment station, Taiwan, in plantations 14-20 years old during the rainy seasons of (1) 1971, (2) 1969 and (3) 1972. Linear regressions are given to relate interception, net rainfall, throughfall and stemflow to rainfall in the open, with separate equations for stands of different density. In (3), interception was less at 1.5x2-m spacing than at 1.5x1.5- or 2x2-m spacing. Graphs and tables have English captions."

Pande, G.C. 1974. Volume prediction in Eucalyptus grandis crops. Indian For. 100(9): 533-543.
From Forestry Abstracts: "Considerable variations in spacing and growth rate in unthinned plantations of E. grandis in Kerala and Tamil Nadu have made preparation of yield tables by normal methods impossible. A curvilinear regression of stand volume on a function (x) of top height and stem numbers per ha was therefore developed, from which data for stand volume and m.a.i. (o.b. and u.b.) are derived and tabulated in terms of age (5,6,7...12 years), stem numbers (800-1600 stems/ha), and site quality."

Panetsos, C.P. (Panetsos, K.P.) 1980. Selection of new poplar clones under various spacings. Silvae Genet. 29(3/4): 130-135.
From Forestry Abstracts: "Two-year rooted plants of the clones HeA/87 (Populus deltoides var. missouriensis x P. nigra var. pubescens), HeZ/17 and HeZ32 (P. deltoides var. missouriensis x P. nigra), HeX/34, HeX/10 and HeX/3 (P. deltoides var. missouriensis x P. "italica" (? P. nigra var. italica)) and 1262 (as control) were evaluated for clone performance with and without competition. Data on height after the sixth year of growth showed significant differences between trees of the same clone and between clones but clone x spacing interaction was not significant. Competition stimulated height increment up to a spacing of 3.93 m². For diameter, significant differences were found within clones and between clones and the clone x spacing interaction was significant. The results indicated that competitive ability is under genetic control and independent of growth rate."

Pardé, J. 1978. (Silvicultural norms for sessile oak forests.) Rev. For. Fr. 30(1): 11-17. (Fr).
From Forestry Abstracts: "A discussion of the optimum number of trees in stands of Quercus petracea at all stages from plantation to harvest. The author gives, and comments on, a table summarizing 5 types of silviculture studied in trial plots at the National Forest Research Centre. The scope for variations, without the risk of losing a large part of the timber production, are shown in a graph."

Parrot, L. 1971. (Climate, a selective factor in the genetic adaptation of Juglans nigra, an exotic species in Quebec, Canada.) Silvae Genet. 20(1/2): 1-9. (Fr, en).
From Forestry Abstracts: "A field test of four provenances of J. nigra was established in 1882-84 at Pointe Platon, near Quebec. After a drastic elimination of many plants by frost during the first years, the remaining stock was planted out at spacings varying from 4x4 to 4x5 m on three different river terraces, where they subsequently formed several well defined populations resulting from the interactions of genotype and environment. Information is presented on the soils, climate, and present state of the plantations, the most northerly in N. America. The populations can be divided into six groups that show great variations in their degree of frost resistance. The best trees are not only superior in increment and quality to the less well adapted ones, but are comparable with trees in the central USA, where J. nigra is at its most productive. Such trees can be selected for seed production and for material for vegetative propagation."

Parviainen, J. 1979. (Early development of Scots pine, Norway spruce, larch and silver birch plantations.) Folia For., Inst. For. Fenniae No. 386, 20 pp. (Fi, en).
From Forestry Abstracts: "In an experiment established in S. central Finland in May 1961, 2+1-yr-old Pinus sylvestris, 2+2 Picea abies, 2+1 Larix sukaczewii and 2+0 and 2+1 Betula pendula were planted on an Oxalis/Vaccinium myrtillus site at 1.7x1.7, 2.0x2.0, 2.5x2.5 and 1.7x1.7 m respectively. Mortality was recorded in autumn 1961 and 1963, and trees were measured in 1976. Spruce had survived best (mortality after 3 growing seasons 13%), whereas pine showed the poorest initial success (mortality 52%). Mean ht. after 16 years was: birch 8.5 m, larch 6.9 m, pine 5.3 m and spruce 3.4 m, and dominant ht. 11.7, 9.1, 6.8 and 5.5 m respectively. Diam. growth was most rapid in larch."

Pedroso, L.M.; Pereira, A. Pinto. 1971. (The adaptation of Pinus caribaea var. hondurensis to the lower Amazon.) Divisão de Documentação, Serviço de Treinamento e Pesquisas Florestais, SUDAM, Belém., 35 pp. (Pt, en).
From Forestry Abstracts: "Presents data for growth up to the age of 8 years of a plantation of P. carabaea var. hondurensis established at an initial spacing of 2x2 m in 1962 at Curuá-Una, Pará, on a plateau of ca. 150 m alt. A selection felling was made in 1970 to leave an individual mean b.a. of ca. 0.0177 m^2. Stand data after the felling are given, with measurements (dimensions, form factor, bark %, growth rings etc.) of two representative felled trees."

Penafiel, S.R. 1973. Preliminary results of the study on spacing of Benguet pine (Pinus insularis, Endl.). Philipp., Bur. For., Occas. Paper No. 49. 6 pp.
From Forestry Abstracts: "Tabulates and discusses results of measurements 5, 10 and 15 years after establishment of a comparative trial of Pinus insularis (P. kesiya) planted at spacings of 1x1, 2x2, 3x3, 4x4 and 5x5 m. The closer spacings are associated with best height growth, and the wider spacings with best diameter growth."

Persson, A. 1975a. (Spacing and the quality of sawn timber in Scots pine.) Sver. Skogsvårdsförb. Tidskr. 73(5): 433-441. (Sv, en).

From Forestry Abstracts: "Logs from a 70-year-old trial of Pinus sylvestris planted at initial spacings of 0.75, 1.25, 1.5, 2.0 and 3.0 m in Västergötland were sawn and graded by three methods, including machine stress-grading. In general, only the butt logs showed serious effects of spacing, but the quality of the middle section of these logs decreased markedly with increased initial spacing. As many recently established softwood plantations in Sweden have a spacing of ca. 3 m at 10 years of age, the prospects for producing timber of acceptable quality from such standards are thought to be poor."

Persson, A. 1975b. (Wood and pulp from Norway spruce and Scots pine at various spacings.) Inst. Skogsprod. Rapp. och Uppsatser No.37. 145 pp. (Sv, en).
From Forestry Abstracts: "Sample logs (at 25%, 50% and 75% of tree ht.) were taken from trees, 45-50 yr old, in trials of spruce (initial spacing 1, 1.25, 1.5, 1.75 and 2 m) and pine (initial spacing 0.75, 1.25, 1.5, 2 and 3 m) in southern Sweden (see FA 37, 4136). The logs were analysed for physical and pulping properties; detailed results are given. The effects of spacing predominated over those of d.b.h. for knot content, extractive content, pulp yield (%) and bursting strength in pine; spacing and d.b.h. both affected knot content, pulp yield (%) and bursting strength in spruce, and basic density, and pulp yield (per unit vol. of green wood) in pine; effects of d.b.h. predominated for basic density, fibre width, pulp yield (per unit vol. of green wood) and tearing strength in spruce, and fibre width, and tearing strength in pine."

Persson, A. 1976. (The influence of spacing on the quality of sawn timber from Scots pine.) Inst. Skogsprod., Rapp. och Uppsatser No. 42. 122 pp. (Sv, en).
From Forestry Abstracts: "A fuller account of work already noticed. (Persson 1975)."

Persson, A. 1977. (Quality development in young spacing trials with Scots pine (in Sweden).) Inst. Skogsprod., Rapp. och Uppsatser No. 45. 152 pp. (Sv, en).

Phipps, H.M. 1973. Effects of thinning on young shortleaf pine plantations in Indiana. USDA, Forest Serv., North Central For. Exp. Sta. Res. Pap. NC-93. 6 pp.
From Forestry Abstracts: "Presents a further report on a study first established in a 14-year-old plantation of Pinus echinata in 1950-51, for which data have already been recorded (see FA 21, 3147), and describes a second study begun in 1956-57, in a 17-year-old plantation in S. Indiana. Both plantations had been planted at 6x6-ft spacing. Plots in the first plantation were thinned to 120, 100 or 80 ft² of b.a./acre at ages 14 and 21, while plots in the second plantation were thinned to 130, 110, 90 or 70 ft² of b.a./acre at ages 17 and 22. Measurements in 1969 showed that thinning to 110 or 120 ft² gave a slight increase in volume yield and b.a. increment. Heavier thinning increased d.b.h. but reduced volume yield by as much as 13%. Form class was changed very little by thinning. It is concluded that the stands do not need thinning at an early age (≥30 years). Unless controlled, hardwood species will probably succeed P. echinata in these stands."

Piene, H. 1978. Effects of increased spacing on carbon mineralization rates and temperature in a stand of young balsam fir. Can. J. For. Res. 8(4): 398-406. (En, fr).
From Forestry Abstracts: "In 22-yr-old stands of balsam fir (Abies balsamea), (a) thinned in 1971 from 19 000 stems/ha to about 1642 stems/ha at a regular 2.4x2.4 m spacing, and (b) untreated, the following were measured in 1973 and 1974: temp., C mineralization (by CO_2 evolution), N mineralization (extractable NH_4-N), and m.c. of forest floor litter (L); and needle wt., % foliar N, and annual b.a. increment of the trees. Average 10-day temperatures of L were lower in winter in (a) than (b), but the threshold for root activity was reached much earlier in spring. CO_2 evolution from and ammonium N content in L were significantly higher in (a) and its biomass was lower. Tree growth was greater in (a), and foliar N content was higher reflecting an increased N uptake by the trees."

Pinchuk, A.M.; Lomov, V.D. 1973. (Effect of the density of young Scots pine stands on the anatomical features of the wood and the accumulation of aerial organic matter.) Nauch. Tr. Mosk. Lesotekhn. Inst. No. 49: 38-42. (Ru).
From Forestry Abstracts: "Wood samples were taken at b.h. on the north side of stems in 30-year-old plantations established at initial planting densities of 2, 4, 8, 16, and 32 thousand plants/ha, in the Moscow region. Mean width of early and latewood, and the number of tracheids all decreased, while the late-wood %, porosity, and ratio of tracheid wall thickness to tracheid diameter all increased with increasing plantation density. Data are given on the weight of the stem, branches and needles of sample trees in each of the plantations. It is concluded that the wood properties improve, and the proportion formed by the stems in the total biomass increases, with increasing plantation density."

Pirtskhalaishvili, S.K.; Chkhaidze, D.K.; Vadachkoriya, T.T. 1975. (Influence of density and spacing of Laurus nobilis on foliage production.) Subtrop. Kul't. No. 5: 67-70. (Ru).
From Forestry Abstracts: "An account of investigations made in Soviet Georgia. Comparative data are presented and discussed, showing that, with biennial cropping of leaves rather than annual cropping, foliage production is greatest if plantations are established with plants spaced at 175x50 cm, i.e. 11 400 plants/ha."

Pisarenko, A.I.; Merzlenko, M.D. 1978. (Plantation density and the index of regularity.) Lesn. Khoz. 1: 58-59. (Ru).
From Forestry Abstracts: "The question of plantation density and an index of regularity of distribution of the plants are discussed. Three definitions are proposed: planting density (number of plants per ha); plant spacing (planting distance and inter-row width); and index of regularity (I_r, obtained by dividing inter-row width by planting distance). Mensurational data are tabulated for several spruce plantations of spacings ranging from 1.2x1.2 m to 2.5x2.5 m and all having I_r close to or equal to 1.0. The plantations are 65-79 years old and the greatest standing vol. (613 m^3/ha) and the second greatest m.a.i. (8 m^3/ha) are found with the initial spacing 1.2x1.2 m. The performance of other plantations is also discussed in relation to density and I_r, and it is concluded that as I_r increases above unity, the performance of the plantation deteriorates."

Pisarenko, A.I.; Merzlenko, M.D. 1979. (The main approaches to solving the problems of the planting density in plantations.) Lesovedenie 2: 49-55. (Ru, en).
From Forestry Abstracts: "The planting of Scots pine and Norway spruce in European Russia since the middle of the 19th century is reviewed in relation to changes in planting density. The trend of planting density is shown in a graph from 1861-1870 by 10-yr periods up to 1961-1970. The mean planting density for pine from 1861 to 1970 varied from 4500 to 10 600 plants/ha (min. 2000, max. 20 000 plants/ha), and the av. over the whole period was 7040 plants/ha. The corresponding figures for spruce were 4000 to 7700 plants/ha (min. 2000, max. 13 000), the av. being 5060 plants/ha. Four concepts related to plantation density are discussed, viz. initial planting density (plants/ha); disposition of the plants (spacing within and between the rows); index of evenness (obtained by dividing the distance between the rows by the distance between the plants in the rows); and density of plantation stocking (the actual number of trees of the planted species present at any given age). The phases when plantation density is of particular interest and importance are the phase of differentiation by degree of dominance, the phase of 'stem formation' (slowing down of ht. growth, and increased self-pruning and diam. growth), and the phase of approaching maturity (with greatest vol. increment and the start of natural regeneration). Some data are tabulated showing: the mensurational details of Scots pine plantations 35 and 36 yr old that had been established at initial planting densities of 5000, 7000, 8000, 11 000 trees/ha; and the growth and survival of Scots pine plantations 26-39 yr old established at spacings of 2.5x1.0 m and 1.3x1.0 m."

Piskun, B. 1972a. (Density of plantations and the qualitative development of Norway spruce stands.) Ved. Pr. Vysk. Ustavu Lesn. Hospod. Zoolene 15: 29-46. (Sk, ru, en, de).
From Forestry Abstracts: "Reports continued studies made in 12 stands 20-54 years old in Slovakia (cf. Piskun 1972b). Comparative data on the effect of initial spacing on qualitative development (stem form, branching habit, natural pruning, etc.) indicated a 1.5x1.5 m spacing to be best."

Piskun, B. 1972b. (The quantitative development of Norway spruce stands and the density of plantations.) Acta Inst. For. Zvolene 3: 275-303. (De, sk, ru, en).
From Forestry Abstracts: "Presents and discusses comparative mensurational data for 12 stands 20 - 54 years old in Slovakia, demonstrating the effect of initial spacing on height and diameter growth, total volume production and assortment production, and the variation of this effect with site type."

Pohjonen, V. 1974. (Effect of spacing on the first-year yield and height growth of some species grown on short rotations.) Silva Fenn. 8(2): 115-126. (Fi, en).
From Forestry Abstracts: "In a trial in N. Finland, seedlings of Alnus incana (a), Populus tremula x P. tremuloides (b), Salix 'Aquatica Gigantea' (c) and S. phylicifolia (d) were planted at various spacings and their weight yield and height growth were measured at the end of the first year. Initial spacing had the greatest effect on the yield of (c) and least on that of (a). Maximum height increment (>100 cm) was shown by (c) at 25-cm

spacing and the yield of (c) (ca. 60 t/ha, fresh weight including foliage) was ca. twice that of the other species."

Polge, H. 1976. (The value of artificial pruning and the methods of effecting it.) France, Bull. Tech. Office Nat. des Forêts, No. 8: 17-27. (Fr).
From Forestry Abstracts: "The economic and silvicultural advantages to be gained by planting conifers at wide spacings and obtaining clean stems by artificial pruning are reviewed, and factors affecting the choice of thinning and pruning schedules (effects on volume production, growth rate, stem form, timber quality etc.) are examined in some detail. Various practical considerations (number of stems to be pruned per ha, pruning season, age of first pruning, height and frequency of pruning, method of pruning, etc.) are discussed."

Pollanschutz, J. 1974a. (Results of an 84-year old spruce-spacing trial in the Weinerwald.) Allg. Forstz. 29(38): 816, 818. (De).
From Forestry Abstracts: "Presents some data from a trial established in 1882 in the Wienerwald with 2500, 4444, 5000 or 10 000 three-year transplants per ha, assessed at intervals from 1923 onward, and subjected since that date to low thinning of various intensities leading to comparable stem numbers (556-620) at 84 years of age. The wide spacing, 2x2 m, gave results superior to those with all other spacings (1x2, 1.5x1.5, and 1x1 m) in volume production and greatly superior in value production, was very much cheaper in establishment and tending costs, and produced stands less susceptible to snow breakage. Reduction of quality owing to increased branchiness was small. Because of delayed closure of the canopy, the wide spacing provided more pasture for game."

Pollanschutz, J. 1974b. (A spacing trial with Norway spruce at 'Hauersteig' (Lower Austria); financial and volume yields (at age 84 (a full account)).) Pages 99-171 in 100 Jahre Forstl. Bundesversuchsanst., Vienna, Austria. (De).

Popov, V.K. 1980. (Row/selective thinnings in Scots pine plantations.) Lesn. Khoz. 2: 28-31. (Ru).
From Forestry Abstracts: "An account is given of thinning trials in 9-yr-old plantations established in the Voronezh region at a spacing of 1.5x0.7 m. The thinning treatments were: row thinning, removing every 2nd, 3rd, or 4th row; and uniform selective thinning. The development of the stands was monitored for 7-10 yr after the thinnings, and the results are shown in tables. These results, together with observations on snow damage in other, similar stands in the region, indicate that in plantations established at an initial density of 8000-15 000 plants/ha, the optimum thinning is one removing every 4th row, combined with a light selective thinning in the remaining rows."

Popov, V.K.; Popova, N.M. 1981. (Features of the accumulation of green pigments in the needles of Scots pine in pure and mixed stands.) Lesn. Zh. 3: 32-35. (Ru).
From Forestry Abstracts: "Investigations were made of the dimensions of the trees, and of the contents of chlorophylls in the needles, in plantations of pure Scots pine and in mixed plantations with 8 or 11 rows of pine alternating with the same number of rows of birch. The plantations

were 12 and 23 yr old, established at a spacing of 1.7x0.7 m. The results (tabulated) indicate that in mixtures the birch creates more favourable conditions for growth of the pine and accumulation of green pigments in its needles than occur in pure pine plantations. The only exception to this is in the row of pine immediately adjacent to and overgrown by the birch; despite the high chlorophyll content of the needles, growth of this row of pine is depressed."

Poynton, R.J. 1981. The silvicultural treatment of eucalpt plantations in Southern Africa. S. Afr. For. J. 116: 11-16.
From Forestry Abstracts: "Approximately 500 000 ha in South Africa have been afforested with Eucalyptus spp., mainly E. grandis, for the production of mining timber, pulpwood, rough building and fencing materials and fuel on a short rotation of 6-10 yr, for telegraph and transmission poles on a medium-length rotation of 10-14 yr, and for sawlogs, veneer-logs and piles on a long rotation of 14-30 yr. Short rotation crops are planted at an espacement of 2.1x2.1 to 2.7x2.7 m and managed under a simple coppice system, from 2 to 4 crops usually being harvested before replanting becomes necessary. Cleaning to 1, 2 or 3 shoots per stool is usually undertaken within 1-2 yr of coppicing, but no pruning or brashing takes place. Medium and long rotation crops are established at 2.7x2.7 m and thinned from an early age. Brashing is commonly practised, but live pruning has not proved beneficial. The site is usually replanted after clearfelling. From author's summary."

Prado Donosso, J.A.; Aguirre Alvarado, J.J. 1979a. (Spacings in plantations of Pinus radiata.) Chil. For. 5(47, suppl.). 7 pp. (Es).
From Forestry Abstracts: "An account of trials in two regions of Chile using spacings from 1x1 m to 3x3 m. The trials were established in 1962; b.a., d.b.h. of tree of average b.a. and heights of dominants and codominants were measured in 1978. Ht. growth was greatest at the lower density spacings; b.a. varied little with spacing. The relationship between total vol. production, vol. of sawlogs produced and spacing was complex, but the widest spacings used gave the greatest sawlog volumes. Branch development and proportion of juvenile wood are also discussed."

Prado Donosso, J.A.; Aguirre Alvarado, J.J. 1979b. (Effect of spacing on the growth of Pinus radiata in Concepcion province, Leonera estate.) Chile, Inst. For., Info. Tecn. No. 69. 28 p. (Es, en).
From Forestry Abstracts: "Results are given of analyses of the growth to 1978 of plots of P. radiata planted in 1964 at spacings of (a) 1.5x1.5, (b) 2.0x2.0 and (c) 3.0x3.0 m. The highest vol. yield was obtained with (b). With (a), many trees were too small to be merchantable. The greatest vol. of sawtimber was obtained with (c); this was 19.2% greater than that obtained with (b). The relative advantages of (b) and (c) are discussed in relation to management considerations."

Prevosto, M.; Proni, G.; Tournon, G. 1980. (Effects of irrigation on a specialized poplar stand in the Po valley.) Cellul. Carta 31(11): 3-39. (It, fr, en, de).
From Forestry Abstracts: "Results are given of the effects of irrigation over 10 seasons on stands of Populus 'I-214' planted at 4x4 and 6x5 m spacing. Up to 3 treatments were given each season, each equivalent to water at 1200 m /ha. All trees were treated against Marssonina brunnea. The

highest mean annual increments in utilizable wood volume were obtained from the plots at 4x4 m, irrigated twice per season. Irrigation once, or twice, per season resulted in a significant increase in the most valuable merchantable assortments. The financial benefits of irrigation, and in particular the increase in income to be derived from quite small quantities of water if applied at the right time, are discussed."

Prokop'ev, M.N. 1976. (Mixed plantings of pine and spruce.) Lesn. Khoz. 5: 37-41. (Ru).
From Forestry Abstracts: "Gives a detailed evaluation of the performance of two mixed plantations of Pinus sylvestris and Picea abies, established in 1905 on a felled area in the Perm region of the USSR. The details of the establishment and development of the plantations are presented, and mensurational data and growth curves are given. The planting stock consisted of 2-year Pine and 3-year Spruce, planted in alternate rows, at densities of 4550 plants/ha in one plantation and 4330 plants/ha in the other. The c.a.i. of the plantation is 11.6 and 13.7 m^3/ha, pine accounting for 52.9 and 39.1% of the total increment. The silvicultural implications of the findings are discussed. It is concluded that on rich sod-podzolic well-drained sandy loams, clay loams and clayey soils, mixtures have higher yields than pure stands. The greatest yield would be with mixtures of 60-80% Pine and 40-20% Spruce, uniformly distributed, the Spruce forming the second storey. Technical maturity of the Pine in such plantations would be at 65-70 years, and the total standing volume at 90 years would be up to 800 m^3/ha."

Proni, G.; Prevosto, M. 1974. (The problem of spacing in specialized poplar stands in the Lombardy-Piedmont plain.) Cellul. Carta 25(9): 28-32. (It, fr, en, de).
From Forestry Abstracts: "Describes a study of the volume of timber obtainable from stands of Populus 'I-214' in this area, established with different types of planting stock at various densities (300 to 10 000 trees/ha) on soils of average fertility, in relation to the revenue received by the grower according to the prices charged for existing commercial assortments and the present costs of production. The results show that: the average annual volume of usable wood per ha. reaches its maximum in stands at 2500 trees/ha, planted with 2-year-old rooted saplings and managed on a 4-year rotation, and declines as density is reduced and the financial rotation is increased; the lower the density and longer the financial rotation, however, the greater are both the proportion of higher-priced assortments and the constant net annual income; except for stands to be managed on very short rotations, which for technical reasons must be planted with cuttings, 2-year-old rooted saplings are the best planting stock; wood-based industries wishing to have their own reserve of raw material in case of temporary shortages on the open market, and not primarily concerned with revenue, should plant at medium densities (but not at >2500/ha) and should probably use 2-year-old rooted saplings."

Proni, G.; Prevosto, M. 1979a. (More on the economic aspects of spacing and thinning in poplar stands.) Cellul. Carta 30(9): 3-23. (It, fr, en, de).
From Forestry Abstracts: "Growth and yield of plantations of Populus 'I-214' at very close spacings (3x2, 4x2 m) and close spacings (4x3, 5x3, 4x4, 6x3 m), thinned and unthinned, and at medium spacings (6x4, 6x5, 8x4,

6x6 m) and not thinned, were studied at Casale Monferrato, northern Italy. Detailed numerical data are presented. Timber yields from unthinned plantations at very close and close spacings were always higher than from thinned plantations at these spacings. M.a.i. in plantations at these spacings, whether thinned or not, was always greater than that in plantations at medium spacings. However, plantations at medium spacings always gave a higher economic return because of the greater value of the merchantable assortments obtainable and the lower costs of production. In the present (1979) state of the market for industrial wood in Italy the desired increase in poplar-wood production could best be achieved not by using closer spacings but by increasing the number of plantations at a spacing of about 30 m^2 per tree in soils of good fertility. From authors' summary."

Proni, G.; Prevosto, M. 1979b. (The economic aspects of spacing and thinning of poplar stands.) Riv. Econ. Agrar. 34(3): 635-648. (It, en).
From Forestry Abstracts: "A report based on spacing and thinning trials at the Poplar Research Institute of Casale Monferrato and a general review of the spacing question for poplar in the Po valley. It is concluded that although the greatest production is from close spacing the best economic results are obtained from medium spacing (30 m^2/tree)."

Pulinets, M.P. 1981. (Plantations of Scots pine in the Maritime provinces.) Lesn. Khoz. 4: 28-30. (Ru).
From Forestry Abstracts: "Details are given of the performance of Scots pine in a plantation in the Upper Ussuri region of the Soviet Far East (149 days/yr with air temp. over 10°C, frost-free period 148 days, annual precipitation 645 mm). The soil was a shallow light clay, brown with slight podzoliation and gleying, previously used for agriculture. The plantation had been established in spring 1955, using 5-yr nursery seedlings and with a spacing of 0.5x2 m (10 000 plants/ha). Data are given on growth up to 1977. Site class is equivalent to site class I in European Russia. Scots pine is considered to be a promising species for planting in the Soviet Far East."

Quaynor, S.O-A. 1971. Espacement trial of Cedrela odorata L. at Pra Anum Research Station. Ghana, For. Prod. Res. Inst., Tech. Newsletter 5(1/2): 16-19.
From Forestry Abstracts: "Gives data on height after one growing season in a taungya plantation in Ghana, in which tree spacings of 16 1/4x16 1/2, 22x8 1/4, 33x8¼, and 49 1/2x8 1/4 ft were compared. Preliminary results indicated that height growth at 16 1/2x16 1/2 ft was not significantly different from that at 49 1/2x8 1/4 ft."

Razin, G.S. 1979. (Changes in the canopy density of single-storeyed stands.) Lesovedenie 1:20-25. (Ru, en).
From Forestry Abstracts: "The development of crown density and canopy density in single-storeyed stands of spruce (Picea abies) is discussed, and formulae are derived to express the total area of the crown projections of all the living trees, and the canopy density. Graphical models are constructed, showing the change in crown density with age from 0 to 120 yr, for 5 density categories, ranging from very dense (67 000 plants/ha), to exceptionally sparse (1800 plants/ha), growing in approximately equal conditions. Stands of any initial density in normal conditions attain

their individual threshold crown density (1.0 to 2.0 or more) and threshold canopy density (0.9-1.0), and then open up as a result of natural thinning. Stands that are the most dense in youth will not be the most dense in the later stages, and conversely the stands that are most dense in maturity were not the most dense in youth. The earlier the stands attain threshold density, the earlier their density starts to decline. The greater the initial density of the stands, the more rapidly the stands close canopy and open up. Stands of any initial density (of over 100 trees/ha, uniformly distributed) can achieve their crown threshold density, this depending on the initial number of trees/ha. Threshold canopy density, however, is not greatly dependent on the initial number of trees/ha. These findings are discussed, and recommendations are made on the growing of high-yielding stable stands of spruce."

Recklinghausen, H. von. 1981. (Norway spruce Christmas tree production in a metropolitan area.) Allg. Forstz. 46: 1223-1224. (De).
From Forestry Abstracts: "Silvicultural, marketing, and management aspects are discussed of a 1 ha plantation near Solingen (N. Rhine-Westphalia). Spacing used is 1.20x1.20 m (giving stock of 7000 trees); with rotation time of 10 yr and 40% mortality, approx. 300 trees/yr become available for sale. Av. tree ht. at sale is 2 m; with price at 10 DM/linear m, av. annual gross revenue is DM6000. Recommendations include: pruning of poorly shaped lower branches to improve attractiveness of trees; and underplanting of new stock under shelter of high-pruned trees."

Reukema, D.L. 1979. Fifty-year development of douglas-fir stands (in Washington) planted at various spacings. USDA, For. Serv., Pacific Northwest For. Range Exp. Sta., Res. Pap. PNW-253. iii+21 pp.

Rockwood, D.L.; Conde, L.F.; Brendemuehl, R.H. 1980. Biomass production of closely spaced Choctawhatchee sand pines. USDA, For. Serv., Southeastern For. Exp. Sta. Res. Note No. SE-293.
From Forestry Abstracts: "Plantations of Pinus clausa immuginata established in Florida appeared suitable for fuelwood production."

Rocuant Trucios, L. 1978. (Spacing quotient. A method for thinning plantations of Pinus radiata.) Univ. Concepción, Centr. Gencas For., Bol. Tçcn. No. CCF-3. 12 pp. (Es, en).
From Forestry Abstracts: "Data compiled from thinning trials carried out since 1959 show that P. radiata plantations growing on Class I and II sites respond to low thinnings applied from 10-12 years of age when the spacing quotient, i.e. the ratio mean spacing/mean d.b.h. of dominant and co-dominant trees (both parameters in cm), is about 18 after thinning. The equivalent b.a. is 26 $\pm$ 2 m^2/ha."

Romanov, A.P. 1975. (Effect of lupin on plantation of spruce and larch.) Lesn. Khoz. 7: 15-17. (Ru).
From Forestry Abstracts: "Mixed plantations of Picea abies and Larix sibirica were established on soddy strongly podzolic soil, fully ploughed and disked. The spacing was 1.5x0.7 m, with 1257 Larch and 8266 Spruce plants per ha, in the form of 3 rows Spruce followed by 2 rows in which one Larch seedling was planted after every two Spruce plants. Perennial lupin was sown in the spring of the year after planting, and the effect of the lupin on the plantations was observed for 10 years. At the end of the

third year after introduction of the lupin, the height of the Larch and Spruce was greater than on control plots, without lupin, and this superiority was maintained thereafter. Fruiting of the Spruce was earlier and more abundant on the lupin plots, and cone size and 1000-seed weight were greater."

Ryabokon', A.P. 1979. (Determining the biological optimum density for Scots pine stands on fresh, fairly infertile, pine site types.) Lesovedenie 2: 16-23. (Ru, en).
From Forestry Abstracts: "The results are given of plantation spacing trials established in the Kiev region and the Sumy region in 1940, with 2500-30 000 plants/ha and 8350-12 340 plants/ha; studies are also reported from plantations established at 10 000 plants/ha in the Kharkov region in 1925, where five different thinning treatments had been used. Tables and graphs show stand development in terms of the number of trees and their growth classes. Theoretical definitions of optimum stand density are discussed, and it is concluded that for practical purposes the optimum density is the one ensuring max. current increment of the stands from age 19 to 100 yr."

Sakamoto, T. 1969. (Ten-year growth at different spacing of Larix leptolepis and other 7 species.) Oji Insti. For. Tree Improv. Tech. Note No. 77. 24 p. (Ja, en).
From Forestry Abstracts: "Tabulates and discusses data on the diameter and height growth of L. leptolepis, Betula platyphylla, Populus maximowiczii, Pinus strobus, P. sylvestris, Picea abies and Abies sachalinensis (two stands), 10 years after planting at different spacings in Hokkaido. The results show that initial spacings of 3000 trees/ha for L. leptolepis and 2000 for B. platyphylla and P. maximowiczii can be recommended in view of the growth of these species and the useful pulpwood obtainable from first thinnings. Recommendations for the other species cannot yet be made."

Sakss, K.; Banders, V. 1969. (Growing Karelian birch in the forests of Latvia.) Latv. Lauksaimn. Acad. Raksti No. 26: 74-82. (Lv, ru).
From Forestry Abstracts: "Experience in Latvia shows that the best results are achieved on Hylocomium and Vaccinium vitis-idaea sites, with planting stock 0.5-1.0 m high and a planting density of 2500/ha. Plantations should be pruned early."

Sancho, R.; Marfurt, T.A. 1972. (The growth of Quercus palustris in the Paraná Delta.) Idia, Supl. For. 7: 77-84. (Es, en).
From Forestry Abstracts: "Gives some growth data for three plantations of Q. palustris on two different sites in the Paraná Delta. The best growth was shown by a 24-year-old stand (initial spacing 2x2 m, thinned in the 14th year by the removal of 42% of the trees) in which the m.a.i. was 20 m³/ha. On the other two sites, which lacked an upper soil horizon rich in organic matter, the m.a.i. was only 7 m³/ha. It is suggested that it would be advantageous in the region to establish plantations with a longer rotation than the Poplars and Willows customarily planted."

Santander, F.C.; Albertin, W. 1974. (Amyris barbata, a valuable forest species little known in the tropics.) Turrialba 24(4): 373-378. (Es, en).

From Forestry Abstracts: "Describes the names, distribution and botanical characters of A. barbata and the characteristics and uses of its wood, and gives details of the performance of the species in a trial plantation established at a spacing of 3.5x4 m in 1962 in the premontane wet forest zone in Costa Rica on a fairly shallow soil of low fertility. Data are given on d.b.h., total and merchantable height, crown diameter, bark thickness and %, commercial volume, mortality, etc. M.a.i. in volume o.b., height, and diameter were only 2.66 m³/ha, 0.92 m and 1.43 cm respectively."

Saradzhishvili, D.G. 1976. (State of the spruce forests at the (mountain) health resort of Sairme and methods of improving them.) Sb. nauch. rabot po izuch. bol'shogo elovogo luboeda v Gruzii No. 2:198-207. (Ru).
From Forestry Abstracts: "The over-thinned state of the forests (owing to mass destruction of Picea orientalis by Dendroctonus micans) in Soviet Georgia has led to an urgent need for plantations to restore the protective function of the forests, especially near the timber lines. Sites in the upper forest belt (with high rainfall and rapid growth of tall grass and shrubs) should be prepared in autumn, in strips at least 1 m wide on slopes up to 15-20°, and in plots of 1x1 to 1x2 m on steep slopes. Various broad-leaved and conifer species are recommended for the lower (up to 1000 m alt.), middle and upper altitudinal zones: P. orientalis may be planted in the middle and upper zones. Shade-tolerant species should be planted in thinned stands (canopy cover 0.3-0.4) and on shaded slopes. Dense planting is recommended (7000-10 000 stems/ha on clearfelled sites or in very open stands, and at least 3000/ha in thinned stands.)."

Sarigumba, T.I.; Anderson, G.A. 1979. Response of slash pine to different spacings and site-preparation treatments. South. J. Appl. For. 3(3): 91-94.
From Forestry Abstracts: "A further report from the same trial in SE Georgia. Data are presented on ht. survival, d.b.h. and incidence of stem canker at 17 yr old. Better drained soils produced higher growth and yield. Wider spacings resulted in greater d.b.h. but reduced vol. Closer spacings produced a greater merchantable vol., which was offset by higher mortality and planting costs and a high proportion of bark to wood. A compromise spacing of 6x12 ft is recommended. Burn-bedding and burn-harrowing site preparations enhanced growth and increased vol. yield and survival, but burn-scalping was detrimental. Intensively prepared plots produced the greatest vol., despite increased incidence of stem canker."

Sato, S. 1972a. (Difference in the environmental factors in the young Norway spruce (Picea abies) stand at different spacings (II).) J. Jpn. For. Soc. 54(3): 67-73. (Ja, en).
From Forestry Abstracts: "Gives results of measurements, during three successive growing seasons, of air temperature, soil temperature, wind speed etc. in a young Picea abies plantation containing stands at 2000, 3000, 4000 and 6000 stems/ha in Hokkaido. Diurnal variation in air temperature at 1.5 m height did not differ much either between different spacings or between the inside and outside of the plantation. Air temperature at 10 cm height, however, was higher and showed more diurnal variation outside than inside the plantation and, within the plantation, appeared to be lower in the most than in tne least dense stand. Air temperature on the forest

temperature on the forest floor was lower than at 10 cm or 1.5 m height, and showed less diurnal variation; it varied little between spacings. Soil temperature at 10 cm depth varied less than air and surface temperature. During the first half of the growing season, soil temperature was highest outside the plantation (a), second highest in the 3000/ha stand (b) and lowest in the 6000/ha stand (c), but in the second half it was highest in (b) and lowest in (c); this change was probably attributable to the greater penetration of sunlight into (b) (in which the canopy had not closed) than (c), combined with greater conservation of warmth within (b) than outside. Soil temperature at 20 cm depth showed less variation than that at 10 cm, and there was little difference in temperature either between the inside and outside of the plantation or between spacings. Wind speed at 2 m height was much higher outside than inside the plantation, but differences between spacings were small. The table and figures have English captions."

Sato, S. 1972b. (Effect of crown closure on the growth of Abies sachalinensis stands at different spacings.) Oji Inst. For., Tree Improvem. Tech. Note No. 117. 6 pp. (Ja, en).
From Forestry Abstracts: "In an A. sachalinensis plantation established at 3000, 4000 and 5000 stems/ha in N. Hokkaido, the stand at 5000/ha began to close when 11 years old and the stands at 3000 and 4000/ha when 13 years old. In a similar plantation in E. Hokkaido, stands at 4000 and 5000/ha were already closed when 17 years old and the stand at 3000/ha was closing. Data are also given for further stands planted at 2000, 3000, 4000 and 6000/ha. In general, an adverse effect of stand density on diameter growth was apparent soon after crown closure at each stocking."

Sato, S. 1973. (Difference in the environmental factors in the young Norway spruce (Picea abies) stand at different spacings (III).) J. Jpn. For. Soc. 55(9): 270-276. (Ja, en).
From Forestry Abstracts: "Gives results of further observations, during 1971, in a young P. abies plantation in Hokkaido containing stands at 2000, 3000, 4000 and 6000 stems/ha (cf. Sato 1972a). Diurnal variation in air temperature at 20 cm height, both between spacings and between the inside and outside of the plantation, was less than that recorded in 1967 and 1968; reasons are suggested. Diurnal variation in air temperature at 1.5 m height was small, as recorded previously. At 3 m height (i.e. within the crown), air temperature was higher in the stand at 6000 stems/ha than in that at 3000/ha or outside the plantation, especially from mid-May to Aug. Air temperature at 3 m height was slightly higher inside but lower outside the plantation than at 20 cm. Air humidity at 20 cm height, and to a smaller extent at 1.5 m, was lower and more variable outside than inside the plantation; within the plantations at these heights, especially at 1.5 m, humidity in the stand at 6000/ha was slightly lower than in that at 3000/ha. In the latter stand, wind speed at ca. 2/3 tree height was about a quarter of that at the top of the tree, while at ca. 1/2 tree height there was virtually no wind during the growing season. Within the same stand, radiation in May-June was very small (0.2 cal/cm /min, i.e. ca. 1/7 of the radiation outside the plantation). Tables and figures have English captions."

Saucier, J.R.; Clark, A. III; McAlpine, R.G. 1972. Above-ground biomass yields of short-rotation sycamore. Wood Sci. 5(1): 1-6.

From Forestry Abstracts: "In a study of short-rotation coppice management of Platanus occidentalis (cf. Dutrow 1971), the effects of spacing and age on the % yields of the component parts of the tree (leaves, branches, stems, bark) were determined on 2- and 3-year-old seedlings. Leaf %s increased with wider spacing and decreased with age. Branch %s generally increased with spacing and with age. Bark %s did not vary consistently with spacing, but decreased with age. 'Plot sp.gr.' was relatively uniform across all ages and spacings, and 'plot m.c.' was inversely related to both age and spacing. Yields per acre are calculated."

Savina, A.V.; Zhuravleva, M.V. 1978. (Growth and development of pine and oak plantations with different growing space.) Lesn. Khoz. No. 10: 33-35. (Ru).
From Forestry Abstracts: "The question of the optimum feedling area (growing space) for plants in plantations is discussed, and results are described from experimental plantings of Pinus sylvestris and Quercus rubra in the Moscow region. The plantations were formed at spacings of 0.25x0.25, 0.5x1.0, and 1.0x1.5, the oak being established by direct sowing of acorns in 1954 and the pine by planting of 2-yr stock in 1956. Data are tabulated on the dimensions of the trees at 9 and at 23 yr, and also on the anatomical structure of the wood and phloem of the pine at 23 yr, and on the seasonal variations in the m.c. of the phloem of the pine. No thinnings were made in the plantations during the period of the experiments. The results indicate that in these conditions the oak grows best at a spacing of 1.0x0.5 m and the pine at a spacing of 1.5x1.0 m."

Sazon, A.C. 1972. Slope and spacing study of Yemane (Gmelina arborea) in Nueva Vizcaya plantation. Philipp. Bur. For. Occ. Pap. 43. 9 pp.
From Forestry Abstracts: "Twelve months after planting, survival % of G. arborea was unaffected by either slope or spacing (1x1 to 4.5x4.5 m).

Schipper, A.L., Jr. 1976. Poplar plantation density influences foliage disease. Pages 81-84 in Intensive plantation culture - five years research. USDA, For. Serv., North Central For. Exp. Sta. Gen. Tech. Rep. NC-21.
From Forestry Abstracts: "Populus x euramericana (P. x canadensis) clones were planted at spacings of 0.8, 1.0, and 1.4 m in Iowa and Wisconsin. Melampsora medusae (and Marssoniana brunnea in Iowa) infection was more severe at higher planting densities (rust severity at 1.0 and 1.4 m was about equal in 2 relatively resistant clones). It is recommended that stocking density should be such that crown closure does not occur until the 3rd or 4th yr."

Schlaegel, B.E. 1981. Sycamore plantation growth: 10-year results of spacing trials. Proc. First Bienn. South. Silvic. Res. Conf., Atlanta, Ga., Nov. 6-7, 1980. USDA, Forest Serv., Southern For. Exp. Sta. Gen. Tech. Rep. SO-34: 149-155.
Authors' Abstracts: "Results of a 10-year spacing trial for sycamores on a good site in the Mississippi Delta are presented. Total cubic-foot production is correlated to initial number of stems, with the 5x10- and 10x10-foot spacing having twice the volume and weight of the widest spacing of 20-29 feet. Projected ages of peak MAI for the 5x10-, 10x10-, 10x20-, and 20x20-foot spacings are 12, 18, 22, and 30 years, respectively. The

10x10 spacing appears to give the most options for production of either pulpwood or sawlogs.

Schmidt, P.B.; Volpato, E. 1972. (Silviculture characters of some native species of Amazonia. I. Preliminary information on increment in height and diameter.) Acta Amazonica. 2(2): 99-122. (Pt, en).
From Forestry Abstracts: "Tabulates data on the height and diameter increment of 15 species of native Amazonian hardwoods planted in small trial plots (25-300 trees) in 1962-64 on a cleared area in the Ducke Forest Reserve, near Manaus. Some natural regeneration of Cecropia sp. present on the trial area was left until 1966 to provide shelter. The species that have done best to date are Carapa quianensis, Diplotropis sp., Calophyllum brasiliense, Terminalia tanimbouca, Coumarouna adorata, and Scleronema micranthum."

Schmidt, W.C. 1978. Some biological and physical responses to forest stand density. In: Proc. Eighth World For. Congr., Jakarta, Oct. 16-28, 1978.
From Forestry Abstracts: "Results from a 15-yr study of western larch (Larix occidentalis) in the Northern Rocky Mountains, USA at densities from 110 to over 15 000 trees/acre showed that reduced densities increased individual tree growth and stream flow, and reduced susceptibility to defoliation by Coleophora laricella and Choristoneura occidentalis."

Schonau, A.P.G. 1974. The effect of planting espacement and pruning on growth, yield and timber density of Eucalyptus grandis. S. Afr. For. J. 88: 16-23.
From Forestry Abstracts: "Gives results of a study of E. grandis planted at spacings of 10x9, 9x9, 8x9, and 7x9 ft on a low-quality site near Pietermaritzburg, Natal. Mortality was independent of initial spacing or pruning treatment throughout the growing cycle. M.a.i. culminated at 10 years of age. The higher stand densities produced more timber, but the increase in volume was confined to the smaller size classes (5.0 - 12.5 cm top diameter). Pruning the live crown reduced tree size and the volume of useful poles, but not total volume/ha. Sp.gr. was indirectly related to diameter; this relation was not affected by spacing or pruning. Economic implications are discussed."

Schultz, R.P. 1972. Intraspecific root grafting in slash pine. Bot. Gaz. 133(1): 26-29.
From Forestry Abstracts: "Sixteen plantations and four natural stands of Pinus elliottii on old fields in N. Florida were given a single light thinning at ages of 10-35 years, and a count of living stumps was made 10-20 years after the thinnings, in order to estimate the frequency of root grafting. Spacing in the plantations varied from 1.8x2.4 to 3x3 m, and stocking in the natural stands varied from dense to sparse. Spacing was the most important factor affecting root grafting. The % of living stumps was twice as high with a spacing of 1.8 m as with one of 3 m within rows. In plantations 7-15%, and in natural stands 15-25% of stumps were root-grafted to potential crop trees and could act as sources of infection. As many as 70% of the root-grafted stumps may die by the fifth year after felling, but some will remain until the trees to which they are grafted are felled."

Schuster, C. 1978. The effect of plant spacing on the early development of karri (Eucaluptus diversicolor F. Muell.). For. Dep. West. Australia Res. Pap. 44. 4 pp.
From Forestry Abstracts: "A trial was established near Northcliffe, Western Australia, in 1971, with 6 spacings (1.22 to 6.09 m). After 6 yr there was n.s.d. for ht. or d.b.h. between spacing treatments but close spacing produced significantly higher crowns. All the plots were stocked adequately for sawlog production but the two widest spacings (4.57 and 6.09 m) are not expected to provide a full chipwood yield when thinning takes place at 30 yr; the 3.66 m spacing appears to be optimal for maximizing chipwood yield."

Sertmehmetoglu, Z.; Acar, O.; Birler, A.S. 1972. Some investigations on financial maturity of poplar plantations applied to cultivation of P. x euramericana cv. 'I-214'. Poplar and fast Growing Trees Res. Inst., Izmir, Turkey. 24 pp. (En, translated from Turkish).
From Forestry Abstracts: "Determines the financial rotation (i.e. that giving maximum annual income) and the economic rotation (i.e. that giving maximum wood production) for plantations of Populus 'I-214' at spacings of 5x8, 6x6, 5x5, and 3x4 m at Izmir, Turkey. The financial rotations were 13.8, 13.0, 12.7 and 9.9 years, and the economic rotations 14.6, 13.0, 11.0 and 10.0 years respectively."

Shapland, R.E. 1974. Hardwood plantations. Q. J. For. 68(3): 218-222.
From Forestry Abstracts: "Discusses the reasons for planting hardwoods in the UK and describes the three main methods of establishment: (1) the individual system, in which individual trees are planted at a wide spacing; (2) the mixed plantation system, with various mixtures of hardwoods and conifers at conventional spacings; and (3) the pure plantation system, with hardwoods at conventional spacings. The merits of each system are considered with reference to a variety of aims, particularly the production of high-quality timber."

Sharma, R.P. 1978. Yield tables for Eucalyptus hybrids (plantation) for various levels of stocking. Indian For. 104(6): 387-397. (En, hindi, de, fr).
From Forestry Abstracts: "Mysore gum (Eucalyptus 'Mysore hybrid', probably mainly E. tereticornis) has been widely planted in India. The tables presented are based on data from 124 sample plots in pure, unthinned stands in 10 different states. They show, by 1-yr age classed (4-14 yr), crop ht., diam., b.a., vol., c.a.i. and m.a.i. for 3 site index classes and 11 stocking densities (800-1800 stems/ha). Total wood production increased with increasing stocking density; it was also markedly influenced by site index."

Sharma, R.P. 1979. Production potential and other crop characteristics of the first generation coppice of Eucalyptus hybrid. Indian For. 105(2): 89-100. (En, hindi, de, fr).
From Forestry Abstracts: "Tables are presented giving diam., b.a., vol. yield, m.a.i. and c.a.i. for Eucalyptus (Mysore) hybrid by 1-yr age classes from age 3 yr to age 11 yr, for two site classes and for stocking densities of 1900, 2000,...,2900 stems/ha. The data were taken from 20 sample plots in Karnataka, Tamil Nadu, Uttar Pradesh and West Bengal."

Sheedy, G. 1978. (Research and development work on poplars. XII. Effect on the rate and method and timing of fertilizer application on growth.) Que. Serv. Rech. For., Mem. No. 47. xiii+25 pp. (Fr, en).
From Forestry Abstracts: "Populus 'B-201-B' and P. 'Q-36-Q' were grown at 3x3 m spacing at the Cabano poplar farm, Quebec (47°40 N, 69°03 W). Response to fertilizing in the 1st and 2nd years was short-lived, probably owing to poor site adaptations of these clones; P. 'B-201-B' was the better of the two at 4 yr old."

Sheikh, M.I. 1973. Willow (Salix spp.) propagation-new technique. Pak. J. of For. 23(1): 100-105.
From Forestry Abstracts: "Describes an improved local technique developed in Pakistan for producing nursery stock. Cuttings from 11 native and exotic clones were planted at a spacing of 3 in x 3-ft and transplanted after 1 year to 3x3-ft spacing. The 'second-stage' cuttings (2 years old) were planted at 10x10-ft spacing in the Research Garden, Peshawar, in Feb. 1973 and had all sprouted by the middle of March. Heights at the time of planting out are tabulated."

Sheikh, M.I. 1978. Effect of spacing on the growth of hybrid poplar. Pak. J. For. 28(2): 93-94.
From Forestry Abstracts: "One-yr-old plants of Populus euramericana (P. x canadensis aggr.) cv. 'I-214' were planted at 5 spacings in Feb. 1974. Survival after 3 months and ht. and diam. after 4 growing seasons are tabulated. Diam. growth was best at the two widest spacings (5.5x5.5 and 4.6x4.6 m) and worst at the closest (1.9x1.9 m). Ht. growth was best at 1.9x1.9 m."

Sheikh, M.I. 1980. (The effect of spacing on the growth of Populus 'I-214' up to the 4th year from planting.) Cellul. Carta 31(6): 21-27. (It, fr, en, de).
From Forestry Abstracts: "An experiment in an irrigated plantation in Pakistan showed that for optimum diameter growth wider spacings (3.7x3.7, 4.6x4.6 and 5.5x5.5 m) were significantly superior (at 1% level) to the closest spacing used (1.9x1.9 m), and (at 5% level) to the 2.7x2.7 m spacing. For optimum height growth, the closest spacing was slightly superior to the wider spacings."

Shim, P.S. 1973. Octomeles sumatrana in plantation trials in Sabah. Malays. For. 36(1): 16-21.
From Forestry Abstracts: "Summarizes the silvicultural characteristics of this species and reports trials up to 2½ years old on two low-lying sites, with comparative data for Anthocephalus chinensis at one of the sites. O. sumatrana appears to be the faster growing species after the age of 2 years, and to be favoured by closer initial spacing (16x8 ft); one disadvantage is the offensive smell of the logs when peeled wet."

Shinkarenko, I.B.; Zhurova, P.T.; Kravtsovo, P.S. 1976. (The effect of the density of pine plantations on their growth.) Lesn. Khoz. 6: 34-36. (Ru).
From Forestry Abstracts: "In 1966, a spacing trial was established with Pinus sylvestris on a dry Pine site in the Kharkhov region, on soddy, weakly-podzolized soils on old aeolian sands, with the water table deeper than 3 m. The following spacings were compared: 1.5x1.5 m, 1.5x0.65 m,

2.5x1.5 m, 2.5x0.6 m, 2.5x1.0 m, 2.5x0.5 m, and 2.5x0.4 m. Before planting the site was treated with 25% BHC dust at 50 kg/ha to control various species of chafers. Data are tabulated on the mensurational details of the plantations at 6 years, and also the aerial phytomass, amount of roots, numbers of chafer larvae present, etc. The results indicate that at 6 years, the plantations established with 2.5 m between the rows were growing better than those with 1.5 m between the rows. Canopy closure between the rows occurred 1 or 2 years earlier with a spacing of 2.5x1 m than with spacings of 2.5x0.4 or 2.5x0.5 m. Stemwood volume and total phytomass per unit area increased with increasing planting density. Root occupation of the soil and total weight of needles were almost identical for all planting densities from 2500 to 500 plants/ha. The optimum spacing is considered to be 2.5 or 3.0x1 m, i.e. 4000 or 3300 plants/ha."

Shinkaruk, A.I. 1975. (Choice of optimum plantation density by an economic criterion.) Lesn. Zhur. 5: 144-148. (Ru).
From Forestry Abstracts: "The economic criterion chosen was the density ensuring the creation of the highest-yielding plantation with the least expenditure. Data are tabulated on 22 pure 40-year-old Scots Pine plantations established in various conditions in the Ukraine at densities ranging from 1100 plants/ha (3x3 m) to 25 000 plants/ha (1.0x0.4 m). The data show the labour requirement, costs, yield (in cash values), and various indices of economic evaluation for each plantation density. The analysis indicates that the optimum density is 5700 plants/ha (2.5x0.7 m) or 6700 plants/ha (3.0x0.5 m), and these spacings are recommended for B site conditions in the Ukraine, viz. fairly infertile and fairly moist Pine sites."

Sidorov, A.I. 1977. (Seed orchards and stool beds for willows of high tannin content.) Lesn. Khoz. 3: 45-46. (Ru).
From Forestry Abstracts: "A collection of some 20 species and clones of Salix of high bark tannin content has been set up at the Semiluk nursery in the Voronezh region (S. central Russia). The establishment and management of the stool beds and seed orchards are described. Yields of standard cuttings per hectare are about 50% greater from stools spaced at 1x0.4 m than from stools spaced at 2.5x0.4 m. The species containing most tannins are S. caprea and S. cinerae. Orchards of S. caprea should have 400-600 trees/ha, and S. cinerea 800-1000 trees/ha. An orchard of S. caprea containing 300 female trees/ha can produce 35-40 kg of seeds at age 10-15 years.

Siemon, G.R.; Wood, G.B.; Forrest, W.G. 1976. Effects of thinning on crown structure in radiata pine. N. Z. J. For. Sci. 6(1): 57-66.
From Forestry Abstracts: "Plots in a 15-year-old plantation of Pinus radiata (initial stocking 1700 stems/ha and b.a. 40 m /ha) in the Green Hills State Forest, New South Wales, were thinned mainly from below in 1962 at four intensities; and each plot was again thinned 2, 5 and 8 years later to its prescribed b.a. Analysis of data relating to the whole tree, the crown and the branches showed that eight of the eleven variables measured were significantly affected by thinning; only total tree height, mean stem internode length and number of green branches per whorl were unaffected. Thinning caused a significant increase in branch diameter, particularly in the upper mid-crown (corresponding to 50-80% of total tree height), and altered the proportion of branches in the 1-cm and 3- to 5-cm diameter

classes. These proportions decreased and increased respectively with the severity of thinning. The relation between the cross-sectional area of the bole at the green crown base and the total branch cross-sectional area within the crown is shown to be linear and independent of thinning."

Simoes, J.W.; Berger, R.; Leite, N.B.; Bertolani, F.; Nicolielo, N.; Villela Filho, A. 1974. (Study of economics of thinning systems.) IPEF 9: 3-21. (Pt, en).
From Forestry Abstracts: "Describes a thinning tail in a plantation of Pinus caribaea var. hondurensis, established in Nov. 1965 at 2x2 m on a cerrado latosol in Brazil. Eight different thinning treatments were applied in Jan. 1973 (when the mean b.a. of the stand was 38.75 m /ha), viz. row thinning (removing every 3rd row); low thinning to remove 30% of the trees or to leave 25 m b.a./ha; and row thinning (removing every 5th, 9th, 13th, 17th or 19th row) combined with low thinning to leave a b.a. of 25 m /ha. Data are given on the volumes of wood removed, labour performance in the various operations involved in thinning, and b.a. increment after thinning. In general, output in felling, trimming, cross-cutting and stacking was greatest with row thinning alone (removing every 3rd row); there was little difference between treatments as regards volumes of wood removed, output in barking (with a Valon-Kone barker), and b.a. increment in the first year after thinning."

Simoes, J.W.: Mascarenhas Sobrinho, J.; Mello, H.A.; Couto, H.T.Z. 1970. (Fertilizing accelerates the initial development of Pinus caribaea var. bahamensis plantations.) IPEF 1:59-80. (Pt, en).
From Forestry Abstracts: "N, P, K, and Ca fertilizers, alone or in combination, were applied to plots of P. caribaea var. bahamensis at the time of planting out (spacing 3x2 m) on a poor, acid, 'cerrado'-type soil on land belonging to the Champion Celulose S.A., in the Casa Branca area, São Paulo, Brazil. Rates of fertilizer per ha were: 0, 30 and 60 kg N; 0, 50 and 100 kg P 0 ; 0, 20 and 40 kg K 0; and 0 and 3 tonnes of lime. Height measurements after one year, and height and b.d.h. after two years, were recorded. A favourable response to all fertilizers was evident after one year, and to P, K and Ca (but not to N), after two years. The data indicate that in these conditions the best results would be obtained by an application, on planting out, of 3 tonnes lime with 60 kg N + 100 kg P_2O_5 + 20 kg K_2O per ha."

Singh, R.V. 1977. Initial spacing in chir pine plantations. Indian For. 103: 329-335. (En, hindi, de, fr).
From Forestry Abstracts: "Crown diam.-d.b.h. relationships in Pinus roxburghii in Himachal Pradesh were used to estimate the optimum initial spacing to give the max. economically harvestable crop in the shortest rotation period. The spacing should be wide enough to allow open-growth rates until the crop reaches an av. diam. that makes thinning commercial (12 cm in this case), but close enough to allow closure of the canopy after thinning. The calculations indicated the optimum spacing to be 2.5x2.5 m instead of the 3.0x3.0 m used at present."

Smirnov, N.A. 1975. (Features of the growth of young spruce plantations on felled areas.) Lesn. Khoz. 11: 50-53. (Ru).
From Forestry Abstracts: "Gives the results of observations on Picea abies stands planted in 1963 in the Moscow region on areas clear-felled in 1957

and 1961. The site conditions are classified as C_{2-}, (fairly rich soil, fresh to moist); the soil moisture content at 45-50 cm is >80% throughout the growing season but the upper soil horizons are adequately aerated, and the soil is excessively wet only in spring. Data are tabulated on the height increment of the Spruce in relation to various factors, viz. site conditions and the method of site preparation (wide clear strips, with or without sod-skimming, or narrow strips, or with strips of Brich), and the type of planting stock (2+0, 2+4, and 2+7 plants). The investigations indicated that the larger planting stock, planted at a density of 100 plants/ha, was superior to the 2+0 seedlings planted at ca. 4000 plants/ha, because the period of very slow height increment after planting was reduced."

Smith, J.H.G. 1971. Productivity of Western Canadian forests and their potentials for improvement. In Symposium A 5.3, Twelfth Pac. Sci. Congr., Canberra, Australia, Aug. 18-Sept. 3, 1971.
From Forestry Abstracts: "Presents data on the natural productivity of the commercially important tree species of British Columbia, emphasizes the critical role of short-and long-term cyclic variations in total precipitation and soil moisture in stand establishment, and considers, both biologically and economically, the opportunities available to forest managers for control of stocking and density. Results of limited research suggest that the best method of intensifying management of these forests is to grow stands from initially wide spacings to become fully stocked and crowded at harvest time."

Smith, J.H.G. 1976. Spacing trials in plantations (of western hemlock). Pages 210-219 in Proc. Western hemlock Managem. Conf., May 1976. Univ. Wash., Inst. For. Prod., Contrib. No. 34.

Smith, J.H.G. 1978. Design factors from Nelder and other spacing trials to age 20. Commonw. For. Rev. 57(2): 109-119. (En, fr, es).
From Forestry Abstracts: "The results of trials in British Columbia with Nelder design (a circular layout with radial and concentric 'rows') to 15 yr old are compared with 49-tree plot trials to 20 yr old for Douglas fir. Coefficients of variation and means tabulated for many factors show that less than 25 trees are needed to define a particular spacing, making the Nelder design very economical of space. Interactions between species and treatments can be studied in 'spokes' of the layout."

Smith, J.H.G. 1980. Influences of spacing on radial growth and percentage latewood of Douglas-fir, western hemlock, and western red cedar. Can. J. Forest Res. 10(2): 169-175. (En, fr).
From Forestry Abstracts: "Ring width increment and % late wood on a very good site in British Columbia, Canada, is described for 20-yr-old Douglas fir, 20-yr-old western hemlock, and western red cedar planted at five spacings (0.91, 1.83, 2.74, 3.66 and 4.57 m). Cores extracted at b.h. were used to show the effects of spacing through rate and crown development, and of age through number of rings from pith for the years 1965-1976. Percentages of late wood measured by binocular microscope are compared with results obtainable by X-ray methods for analysis of ring widths and densities. Influences of spacing on wood quality are discussed. It is concluded that wide iritial spacings increase ring width and reduce % late wood significantly, but the reduced costs and increased sizes at wide

spacings adequately compensate for the moderate reduction in wood quality. From author's summary."

Solymos, R. 1970. (The importance of optimum stem numbers in silviculture.) Erdész. Kutatas. 66: 25-31. (De.)
From Forestry Abstracts: "A general discussion, illustrated by a graph based on Hungarian sample plots showing growing-space (crown-cover)/d.b.h. relation of major species, and some selected data from Beech and Hornbeam sample plots. Of the species discussed, only Pinus strobus needed less space than Picea abies to reach a given d.b.h."

Solymos, R.V. 1975. (Development of conifer growing in Hungary and the spacing of plantations.) Erdögazdasag és Faipar. 23(7): 15-16. (Hu).
From Forestry Abstracts: "Discusses the spacing of Pines in the afforestation of poor humic sandy soils without groundwater in the Danube/Tisza region of Hungary from the viewpoint of mechanization. On the basis of the results of a trial of 2+0 Pinus sylvestris at 10 different spacings, recommendations are made for afforestation with P. sylvestris or P. nigra: spacing up to 2.5-3 m between rows; optimum 50-70 cm between plants; and planting density to be reduced from 10 000-12 000 to 6000 plants ha, to give a stand density of 4000 stems/ha at 10 years old (lower densities only with exceptionally good stock and planting)."

Stawecka, W. 1971. (Fffect of spacing on the increment of Populus 'Marilandica' in a plantation in the Vistula valley.) Prace Inst. Bad. Les'n. No. 398/400: 29-53. (Pl, ru, de).
From Forestry Abstracts: "Describes investigations in Poland on increment, costs, and yields to age 10 years, in plantations established at square spacings of 2, 3, 4, 5, and 6 m. The denser plantations (2x2 and 3x3 m) required thinning in the third year, but even so were unable to compensate thereafter for lost volume production compared with the plantations at wider spacings. Volume production per ha was greatest in the plantation spaced at 4x4 m, and this spacing also gave the best financial results."

Steinbeck, K.; McAlpine, R.G.; May, J.T. 1972. Short rotation culture of sycamore: a status report. J. For.: 70(4): 210-213.
From Forestry Abstracts: "Discusses recent work in Georgia on the growing of Sycamore (Platanus occidentalis) on very short coppice rotations (cf Cutrow 1971) and on the properties of juvenile Sycamore fibre for industrial use. Data are given on: (1) the effects of spacings ranging from 1x4 to 6x4 ft on yields from Sycamore seedlings cut at ages 1-4 years to initiate coppice growth, and on the yields of coppice subsequently grown from the stools on rotations of 1-3 years; (2) the neutral sulphite semi-chemical pulping and papermaking properties of 4-year-old Sycamore; and (3) the strength properties of a corrugating medium made from the entire aerial portion of 4-year-old Sycamore, in comparison with data on a commercial corrugating medium."

Stepanov, L.I. 1975. (The age of canopy closure of Scots pine plantations in the 'ribbon-like forests' (of Kazakhstan).) Lesn. Khoz. 4: 50-52. (Ru).
From Forestry Abstracts: "Gives data from measurements of crown development on trees in plantations up to 23 years old, on (1) meadow chestnut carbonate soils, (2) chestnut carbonate soils, and (3) soddy sandy soils.

In plantations established at a spacing of 1.5 m between the rows, canopy closure occurs 2-3 years earlier on (1) and (2) than on (3). Complete canopy closures occurs at 15 years, and the first thinnings should be made at 16-20 years, removing only the dead and badly suppressed trees, without reducing the relative density of the stand."

Stern, R.C. 1972. Poplar growing at close spacing. Timber Grower 44: 20-24. (Another version found in Q. J. For. 1972, 66(3): 230-235).
From Forestry Abstracts: "In the context of the future limitation in the market for wide-grown Poplar for match splints in the UK, an evaluation is made of the results of the Forestry Commission's experiments on close spacing (e.g. 2.1 m) and coppicing of Poplar (variety 'TXT 32'). Profitability assessments for three different sets of rotation, three different delivery costs and various interest rates indicate that growing at close spacing is reasonably profitable and that coppicing may be even more so, particularly if the markets (especially pulp mills) are not too distant."

Stiell, W.M. 1969. Crown development in white spruce plantations. Can., Dep. Fish. For., For. Br., Publ. No. 1249. iii+12 pp.
From Forestry Abstracts: "The dry weight and distribution of foliage, and the number, basal area and distribution of branches, were measured on 43 trees of Picea glauca aged 13-41 years in closed stands with initial spacings of 3x3, 4x4, 5x5, 6x6 and 7x7 ft at Petawawa, Ontario. Regression equations of foliage dry weight on various stem and crown measurements were determined. The most significant and useful independent variables were: diameter of the stem at the base of the live crown; the product of the length and width of the live crown; and the product of d.b.h. and the length of the live crown. The addition of variables of age, spacing, crown class or height by stepwise regression did not materially improve the correlations."

Stiell, W.M. 1971. Comparative cone production in young red pine planted at different spacings. Can. For. Serv., Publ. No. 1306. 8 pp. (En, fr).
From Forestry Abstracts: "A Pinus resinosa plantation at Petawawa, Ontario, established at a spacings of 4x4, 6x6, 8x8, 10x10, 14x14 and 21x21 ft, produced its first heavy cone crop in 1970 at 18 years of age. Canopy had closed at spacings of 10 ft and the dominant height was ca. 30 ft. Cone counts made whorl by whorl showed that virtually the whole cone crop was borne on the free-growing top (above the level of crown contact), thus covering progressively more of the crown with increasing spacing, down to ca. ground level at a spacing of 21x21 ft. Cone crops increased with tree size within each spacing, no cones being found on trees of 5 in d.b.h. Both the number of cones per tree (in a given d.b.h. class) and the total number of cones per acre increased markedly with spacing up to 21x21 ft. The smaller total crop in the open-grown stand at 14x14 ft implies that crown diameter is important as well as full illumination. (cf FA 32, 4234)."

Stiell, W.M.; Berry, A.B. 1977. A 20-year old trial of red pine planted at seven spacings. Can. Dep. For., Forest Mgmt. Inst. Inf. Rep. FMR-X-97. vi+25 pp. (En, fr).
From Forestry Abstracts: "Pinus resinosa 2+2 transplants were planted at spacings of 1.2x1.2 m to 4.3x4.3 m near Chalk River, Ontario in 1953. Data

are presented from annual measurements of total ht., ht. to the base of the live crown, d.b.h. and max. crown width in 1962-72 and from measurements of stand development in 1962, 1967 and 1972. Crown dimensions were greater at wider spacings for a given ht., and d.b.h. was directly related to spacing and height."

Stoiculescu, C.D. 1973a. (Results of the first thinning trials in single-clone stands of hybrid black poplar.) Rev. Padurilor 88(2): 81-89. (Ro, ru, en, de, fr).
From Forestry Abstracts: "Reports the increment and yield of young plantations of Populus 'Robusta R-16' in two areas of SW Rumania, planted respectively at spacings of 2x2 and 4x4 m, thinned (by 25-50%) respectively at 3 and 5 years old, and re-measured respectively 1 or 2 years and 1 year later. It is concluded that dense stands (spaced at 2x2 to 3x4 m) on moderately fertile sites (height 10.4 m at 5 years old) will respond to heavy early thinning, e.g. by systematic removal of 50% of the stems in diagonal lines; on fertile sites (5-year height 12.9 m) the same measures do not increase yield and may reduce or only slightly increase the c.a.i. Similarly, stands planted at moderate density (4x4 to 5x5 m) on very fertile sites (5-year height 14.7 m) do not respond to thinning at 5 years old."

Stoiculescu, C.D. 1973b. (Studies on the increment and on methods of tending of single-clone stands of hybrid black poplars.) Bucharest, Rumania: Redactia Rev. Agric. 67 pp. (Ro, en, fr, de).
From Forestry Abstracts: "Describes studies during 1966-70 in experimental plantations of Populus 'Robusta R-16' up to 6 years old at three sites in the Danube and Olt flood-plains, SW Rumania including work already noticed (See Stoiculescu 1973a). Initial spacings ranged from 2x2 m to 8x8 m. Mechanical thinning at 50% intensity was compared with selective thinning at 25% or 35% intensity and with unthinned controls. Thinning was required at 3 years old at the 2x2-m spacing and at 5 years old at 4x4 m. The volume increment % of the residual stand, during the next two years after thinning, increased with increasing thinning intensity and with decreasing site quality at a given intensity. On the better sites, only the 50% thinning gave a volume increment % that was greater than that of the controls, and all thinning treatments depressed total yield. On the medium sites at 2x2-m spacing, thinning increased total yield. However, irrespective of site quality, only the thinnings at 4x4-m spacing (at 5 years old) yielded profitable assortments. Conversion of branchwood was unprofitable. Thinning did not affect stem excentricity but increased windfirmness (already quite good in these plantations). Many of the discussions are also reported in another paper. See also Stoiculescu 1974."

Stoiculescu, C.D. 1974. (Optimizing the utilization of site potential and the silvicultural management of single-clone hybrid black poplar stands.) Rev. Padurilor 89(6): 284-290 + summaries. (Ro, ru, en, de, fr).
From Forestry Abstracts: "Discusses, with special reference to Poplar growing (see preceding abstract): the geometry of different types of spacing and arrangement, and the relation between the crown cover (regarded as essentially circular) and the available growing space per tree; and different systems of thinning, especially those that open up the stand as uniformly as possible. It is concluded that triangular (hexagonal)

arrangements offer the best possibilities for rational silviculture, except within the subtropics or where intercropping is practised, and that the yield of Poplars cannot be considered without reference to the geometric pattern of thinning."

Stredicke, R. 1977. (Economic considerations on narrow and wide spacings in poplars.) Holzzucht 31(1-2): 16-17. (De).
From Forestry Abstracts: "A study of costs and returns from 20-, 30- and 40-yr-old stands of black poplar planted at 5x5 m spacing (400 trees/ha) and thinned according to the yield tables of Rätzel for Populus 'Robusta'. Results suggest that planting at a wider spacing (8x8 or 8x9 m) would be much more profitable. The spacing of balsam poplars is briefly discussed."

Streyffert, T. 1979. (Today's forestry - and tomorrow's - a silvicultural system for high-value production.) Sver. Skogsvårdsförb. Tidskr. 77(5/6): 5-18. (Sv).
From Forestry Abstracts: "Problems facing the Swedish forestry and forest industries are briefly reviewed. It is argued that the present policy (including subsidized thinnings) and silvicultural practices in Sweden favour the production of small-dimension timber at high cost. A new silvicultural system is proposed which involves the establishment of plantations with initial density as low as 1200 trees/ha, of which about half could be felled relatively early and the rest managed intensively with mechanized pruning to produce large high-quality timber at final felling. The wide space between the trees would serve as a network of spur roads, thus permitting full mechanization of tending and harvesting operations. Broadleaves emerging between the lines could be harvested for fuel wood. Several other merits of this system are pointed out."

Strong, T.F.; Zavitkovski, J. 1978. Morphology of jack pine and tamarack needles in dense stands. USDA, For. Serv., North Central Exp. Sta. Res. Pap. No. NC-153. 6 pp.
From Forestry Abstracts: "Surface area, needle length and dry wt. were measured for sample needles from the upper, middle and lower thirds of the crowns of 6-yr-old Pinus banksiana and Larix laricina planted at spacings of 9x9, 12x12 and 24x24 inches. Needles from the lower third of the crown were shorter and had smaller surface area and dry wt. than those from the upper crown; needles from the middle section were intermediate. The differences between needles from different parts of the crown were greater in samples from dense plantations."

Sutton, W.R.J. 1971. Growth characteristics of seedling and clonal stands. Pages 38-39 in Rep. For. Res. Inst. for 1970, N.Z. For. Serv.
From Forestry Abstracts: "Measurements of the form, branching habit, etc. of a stand of grafted trees of Pinus radiata from non-selected parents, grown at 12x12-ft spacing, were made when pruning at a height of 7-14 ft. Compared with equivalent data from a pruning trial on seedling trees, grafted trees appear to have similar d.b.h., smaller knotty cores, greater upper-stem diameters (and therefore greater volume), considerably more whorls per unit length, more branches but fewer per whorl, smaller branches, and considerably more stem cones. Results indicate that timber quality may not be as high in clonal stands as is often supposed. The growth characteristics of the grafted trees are considered to be comparable

with, and the results are taken to illustrate what might be expected from, trees grown from cuttings."

Szodfridt, I. 1972. (Comprehensive evaluation of spacing experiments with Populus 'Serotina' at Tolnasziget.) Kisérletügyi Közlemenyek Erdögazdasag es Faipars 63(1/3): 29-46. (Hu).
From Forestry Abstracts: "Presents the results of a 21-year-old trial, established at spacings of 2x2, 4x4, 6x6 and 8x8 m, in the Danube floodplain. Thinning was done only in part of the 2x2-m plots. The main conclusions are that: height is not influenced by spacing; mean diameter increases, but growing stock decreases, with wider spacing; and regular thinning from a narrower to a wider spacing increases the yield compared with that of a stand planted at the wider spacing, but decreased the yield (by ca. 20% over the rotation) compared with that of a stand left unthinned at the narrower spacing until the death of the trees."

Tarasenko, V.P.; Tarasenko, I.A. 1971. (Establishing spruce plantations with large planting stock.) Lesn. Zh. 14(5): 147-148. (Ru).
From Forestry Abstracts: "A note summarizing experience in Belorussia on the performance of several plantations established with large Picea abies planting stock, i.e. plants that had been 3-7 years in transplant lines, and wildings 40 cm high. The plants were planted in spade-dug holes, with a minimum of ground preparation and weeding. The oldest of these plantations was established in 1912 at a spacing of 2x1 m. Data on costs, growth, and the necessary subsequent tending indicate that it is more economic to use the large planting stock than conventional 2-year seedlings, and that the rotation can be shortened, quantitative maturity occurring at 50-60 years."

Tekhneryadnov, A.V.; Askarov, K. Zh. 1973. (Variation in tracheid dimensions of Scots pine in planting of different density.) Pages 173-177 in Materialy Nauchn.-tekhn. Konf. posvyashch. 25-letiyu Lesokhoz. fak. Kazakhsk. S.-Kh. inst. Alma-Ata, USSR. (Ru).
From Forestry Abstracts: "The length of early- and late-wood tracheids from young trees grown at densities of 10, 25, 50 and 100 plants/m^3 were determined. Tracheid length decreased with increasing plant density. The variation in length of late-wood tracheids decreased, whereas that of early-wood tracheids increased with increasing plant density. The variation caused by changing density was 31 and 27% respectively for length and width of late-wood tracheids, and 13 and 9% for early-wood tracheids, the variation caused by the differentiation of tree diameters within treatments was respectively 9 and 17% for early-wood tracheids and 10 and 10% for late-wood tracheids."

Thomasius, H. 1972. (Utilization of a growing space (by trees) and growing-space regulation: a contribution to thinning theory.) Wiss. Z. Techn. Univ. Dresden. 21(6): 1205-1218. (De).
From Forestry Abstracts: "Discusses the utilization of growing space by trees from a theoretical point of view. A formula is presented for a 'growing space constant', K, expressing the productive capacity of a site during the whole life of a stand, as a function of the logarithms of stand height and stem number, and an exponential expression of ageing rate x age. The application of the theory to thinning schedules and to optimum and critical stand densities is discussed. One logical conclusion arrived at

is that the interval between thinnings should be based on equidistant height differences. Stem numbers in relation to mean heights are tabulated for Norway Spruce and Scots Pine of different quality classes."

Thomasius, H. 1974. (A method for determining the number and spacing of plants in afforestation with monopodial species of high volume (rather than quality) production.) Wiss. Z. Techn. Univ. Dresden 23(5): 1235-1247. (De).
From Forestry Abstracts: "In order to draw economic conclusions from the considerable volume of research data, one must first define the growth habit and the aim of production in a given plantation. The method described relates to the 'Spruce type' of species (with strongly monopodial growth) managed for volume yield, and also takes into account site quality, survival, and economic conditions. Detailed tables and graphs are presented for Picea abies (based on Wiedemann's tables), suitable for rapid determination of optimum spacing and also of response to thinning, yield, etc.: the results generally confirm the E. German standard inter-row spacings of 2 or 2.5 m. The characteristics of the strongly sympodial 'Beech type' are briefly compared."

Thomasius, H. 1975. (Principles for determining the numbers, spacing and arrangement of plants.) Soz. Forstwirtshaft 25(11;12): 346-348, 370-373. (De).
From Forestry Abstracts: "Summarizes the various theoretical and practical aspects involved in planning the density and spatial arrangement of trees in plantations throughout the rotation, for which there is abundant evidence from long-term trials. The basic method applies the author's formula for growing space (see FA 35, 1804), but the main emphasis is on the factors yield, habit, production aim, stand stability, technological constraints, demand for smallwood, and economics. The arrangement of trees at planting time is discussed with reference to mortality and to the desirability of wider spacings between the rows."

Thomasius, H.O.; Thomasius, H.H. 1978. (Derivation of a method for the calculation of optimum stand density for growth and yield.) (Abstract.) Beiträge für Forstwirtshaft 12(2): 79. (Eng, de, ru).
From Forestry Abstracts: "The theoretical basis for calculating optimum stand density is discussed. Input data are the vol. increment of a single tree (v) and its growth area (f). Max. v^1 is reached at the transition from closed canopy to solitary status, when further increase in f has no effect. Increment per unit area is calculated from stem number (n) and v^1. The curve has zero points at $n = 0$ and $n = n_{max}$ or $f = f_{min}$ and a max. (marking optimum density) at $dv^1/df = 0$."

Tihanyi, Z.; Tompa, K. 1972. (Willow plantations on mined peatland at Hanság-Királytó.) Kisérletugyi Közlemények Erdogazdaság és Faipar, 63(1/3): 69-84.
From Forestry Abstracts: "During mechanical exploitation of peat on this site (in the marshes of NW Hungary), an overlying humus layer 20-30 cm thick was deposited on the gley subsoil. The site was ridged by machine, and drainage ditches were dug between the ridges. Sets or peat-pot plants of 26 Willow clones were planted on the ridges in randomized blocks on a 1.5-ha area in March 1968, at a spacing of 3.2x1 or 2.9x0.9 m. The experiment was evaluated in late Oct. 1970: the annual increment of the best

clones was 12 m /ha. Five clones of Salix alba and two of S. alba x S. fragilis are recommended for similar sites. Other conclusions are that: a drained soil layer 50 cm deep is required for normal development of Willows from mid-April onwards; the ridges should be as high as possible; and there is no advantage in planting rooted cuttings."

Timofeev, V.P. 1974. (Very old provenance trials of Pinus sylvestris.) Lesn. Khoz. 8: 31-38. (Ru).
From Forestry Abstracts: "Describes the results of the Scots Pine provenance trials established in the 1880s and 1890s by Prof. M.K. Turskii at the Timiryazev Agricultural Academy in Russia. The main provenances were: (I) local (Moscow and Vladimir regions); (II) northern (Archangel, Perm, Vologda and Kostroma regions); and (III) southern (Tambov region). The plantations were established at an initial density of 32 000 plants/ha, and were apparently left unthinned except for the removal of dead trees. Data are presented on the performance of the later series of provenances, i.e. provenances 80 years old in 1970. The local provenances have the greatest standing volume and also the greatest total yield (standing volume plus mortality). Invasion by Birch was also less in the plantations of the local provenances. Differences between the provenances were greatest in youth, decreasing later, though the local provenances remained superior throughout their life. Investigations of the physical and mechanical properties of the wood revealed only small differences between provenances, though again the local (Moscow) provenances was superior as regards density."

Tingle, A.C.: Laar, A. van. 1971. The silviculture of Populus deltoides. South Afr. For. J. 76: 14-18.
From Forestry Abstracts: "Reports the results after 3 years of a thinning experiment in Natal, where close spacings are favoured. Two stands on good sites were thinned at 7 or 8 years to a spacing % (mean distance between trees in % of mean height of stand) ranging from 22 to 37%. Volume increment and value increment decreased with increasing spacing %; b.a. increment decreased with increasing spacing % in the first year but not in the following years. The economic implications are discussed and it is suggested that the present policy of planting at 9x9 ft with a rotation of ca. 20 years should be replaced by planting at 16.4x16.4 ft (5x5 m) with a 15- to 17-year rotation, largely in order to increase the value of match timber from the first thinning."

Tolkachev, L.N. 1976. (Comparative yield of line plantations and 'nest' plantations of oak. Lesn. Khoz. 6: 36-38. (Ru).
From Forestry Abstracts: "Compares different types of Oak (Quercus robur) plantation in Belorussia, viz. (1) line plantations established by planting at a density of 10 000-14 000 plants/ha; (2) 'nest' or clump plantations established by sowing acorns on prepared patches of 3x3 m to give initial densities of ca. 10 000 plants/ha; and (3) as (2) but on patches of 4x4 to give 14 000 plants/ha. Data are tabulated on the growth and yield of the plantations up to age 40, including yield by assortments. Diameter growth was better in (1) than in (2) or (3). It is argued that it is worthwhile to compile assortment yield tables even for young stands of Oak."

Tölle, H. 1976. (Increasing increment in old pine stands by nitrogen fertilization in relation to stand density.) Beiträge für die Forstwirtschaft 10(3): 117-120. (De, ru, en).
From Forestry Abstracts: "A study was made of the effects of 3 applications of 120 kg N/ha to a 90-year-old pine (Pinus sylvestris) stand on sandy soil in the Randenburg area. Initial stand density varied from 0.63 to 1.10. Application of N significantly increased 100-needle mass and 4-year volume increment. In unfertilized pots, stand density increased by 0.044 and in N-treated plots by 0.055. The additional increment resulting from N fertilization was significantly correlated with stand density. Decreasing density by 10% resulted in about 10% decrease in additional increment."

Tomazius, Kh. O., (Thomazius, H.O.) 1978. (Determination of the optimum stand density.) Mezhvuzovskii Sb. Nauchnykh Trudov, Leningradskgya Lesotekhnicheskaya Akad. im. Kirova, Lesovod. Lesnye Kul'turyi Pochvovedenie No. 7: 14-23. (Ru).
From Forestry Abstracts: "Equations are developed for predicting optimum density, based on the relation between the area occupied by a single stem, the vol. per stem and the vol./ha for a stand. Studies on spruce (Picea abies) stands at Grillenburg, E. Germany, gave somewhat variable results; possible refinements are discussed."

Torokhtun, I.M. 1981. (Density, water supply and growth of tree species in shelterbelts.) Lesn. Khoz. 7: 32-34. (Ru).
From Forestry Abstracts: "In 1972, trials were started in a number of agricultural enterprises in the USSR in which several species were used at various spacings to create shelterbelts on different types of soil. These included Betula verrucosa (B. pendula) on ordinary chernozem, Ulmus pumila var. arborea on southern chernozem, Robinia pseudocacia on dark-chestnut soil, Populus balsamifera on chestnut soil, and U. pumila var. arborea on light-chestnut soil. Soil moisture supply and tree growth are discussed with particular reference to plant spacing. The usual spacing adopted, viz. 1-1.5 m apart in the rows, with the rows 2.5-4 m apart, does not result in better growth in the early years than a wider spacing with 2-3 m between the plants in the rows. After canopy closure in the rows and with regular soil cultivation between the rows, these low-density plantings have better supplies of water available and are more viable than the normal denser plantings."

Tsanov, T.Ĭ. 1974. (Growth and yield of Osier Willows in relation to soil conditions and plantation density.) Gorskostop. Nauka 11(4): 38-50. (Bg, ru, fr).
From Forestry Abstracts: "Compares the performance of ten species and varieties of Osier Willows planted at four different spacings on different soil types at four sites in Bulgaria. The most promising Osiers were Salix triandra, S. americana X S. daphnoides, S. viminalis X S. purpurea, and S. viminalis. Growth was best on alluvial meadow or on accumulated chernozem soils, where the annual increment of shoots exceeds 2.0-2.5 m and yeild is 25-30 t/ha (green weight). The best spacings were 60x15 and 70x20 cm."

Tsanov, T.Ĭ. 1978. (Studied on the vegetative propagation of willows.) Gorskostop. Nauka 15(5): 28-41. (Bg, ru, fr).

From Forestry Abstracts: "Investigations are reported on the propagation of 3 willow clones Salix alba Bg 2/64 (the local Bulgarian clone), S. alba Valenza I-1/59 (Italian), and S. alba Donja Siga 1/23 (Yugoslavian) by cuttings. The cuttings were planted at spacings of 200x15, 200x30, 200x45, and 200x60 cm. The plants were grown as 1/1 (i.e. 1-yr root, 1-yr stem), 1/2 (2-yr root, 1-yr stem), and 2/2 (2-yr root, 2-yr stem). The best method was to use 1/1 plants, at a spacing of 200x15 cm; this gives 1-yr plants 250-300 cm tall and 2-2.5 cm in diam. at the base."

Tyshkevich, G.L. 1976. (Biological principles of creating Beech plantations.) Lesn. Khoz. 2: 57-61. (Ru).
From Forestry Abstracts: "Gives results of comparative trials in Soviet Moldavia in 1966-73 aimed at determining the best way of establishing plantations of Fagus sylvatica. Three methods of site preparation were compared, viz. partial manual cultivation of strips 1 m wide, partial mechanized cultivation of strips 4 m wide, and complete mechanized cultivation. Plantations were also established at various densities (5, 7, 10 and 20 thousand plants/ha), and with various compositions (pure Beech, Beech/Oak, and Beech/Maple). Data are tabulated on height and diameter growth, various physiological characteristics such as rates of transpiration and photosynthesis, weights of the various organs, and numbers of roots. The results indicate that the best method of establishing plantations is with complete mechanized cultivation of the site; plantations should be pure or in mixture with Oak; the optimum planting density is 10 000 plants/ha."

Ul'yanov, V.I. 1981a. (Natural thinning of Norway spruce plantations on Sakhalin.) Lesovedenie 4: 49-55. (Ru, en).
From Forestry Abstracts: "Studies were made in 45-yr-old plantations established by planting at 1.50x1.44 m (4620 plants/ha) and left unthinned. Complementary studies were also made in parts of the plantation that had been thinned. Data are given in tables and graphs on the amount and pattern of natural mortality (self-thinning) with time. In the first 10-15 yr, self-thinning was more intensive on the better site classes; thereafter, it was directly proportional to current density. Current density at 10-15 yr is a factor that regulates many processes in the stand, and can be used as a classification basis for predicting the thinning, growth and merchantable structure of plantations."

Ul'yanov, V.I. 1981b. (The question of site class.) Lesn. Khoz. 6: 34-37. (Ru).
From Forestry Abstracts: "A detailed analysis was made of the ht. growth of 407 living and dead trees in plantations of Picea abies on the island of Sakhalin. The plantations were site class I, original spacing 1.5x1.5 m; most of the trees that had died naturally were still standing and well preserved. Ht. growth was analysed in 5-yr periods on trees on 20 circular plots 5.65 m in radius. Data are tabulated showing the mean ht. and ht. range for tall, medium and short trees at ages 5, 10, 15...45 yr. Further studies were made of the change with age in the differences between the tall, medium and short trees, and the validity of mean ht. as a basis for evaluation of stand yield is discussed. The influence of thinning intensity on change in mean ht. is also discussed. Recommendations are made for the establishment of improved mean standard curves for site-class scales in the USSR."

Utkin, A.I.; Rozhdestvenskiĭ, S.G.; Ermolova, L.S.; Os'kina, N.V. 1980. (Biological productivity of 22-year plantations of Scots pine and Siberian larch in the Yaroslov region.) Lesovedenie 5: 85-90. (Ru, en).
From Forestry Abstracts: "Data are presented on the growth and biomass of plantations of Pinus sylvestris and Larix sibirica established at initial planting densities of 6500 and 3500 seedlings/ha respectively on former pasture. At 22 yr the total phytomass was 110-115 t/ha, of which 85-100 t/ha was in the stems. The (denser) pine plantation had the greater absolute productivity, but in terms of production per unit wt. of foliage the larch was 43% more productive than the pine. The species were equal in terms of production per unit of cambial area."

Vakulyuk, P.G.; Belyi, G.D.; Shlyamar, E.A. 1980. (Planting density for pure Scots pine plantations.) Lesn. Khoz. 4: 45-46. (Ru).
From Forestry Abstracts: "In 1958, a spacing trial was started in the Zhitomir region of the Ukraine, in which Scots pine was planted at eight different densities (2500-20 000 plants/ha; spacing 1x0.5 m to 2x2 m). The development of the plantations is described, and mensurational data are tabulated for the plantations at 20 yr old. The problem of unprofitable thinnings in young plantations is pointed out, and the advantages of wide spacing between the rows (2.5, 3 and even 4 m) with close planting within the rows (0.5 m) are outlined, on the basis of experience with some other plantations now 60-70 yr old. By removing plants for Christmas trees or for foliage, it would be suitable to bring the plantation to a density of 3000-4000 plants/ha by age 5 or 6, by thinning to a spacing of 1-1.5 m within the rows with a spacing of 2.5 or 3 m between the rows."

Vakurov, A.D. 1979. (A thirty-year trial of growing Scots pine plantations of various densities near Moscow.) Lesovedenie 6: 81-84. (Ru, en).
From Forestry Abstracts: "Plantations were established in 1948 on old-field sites by planting 1+0 seedlings at densities of 2000, 4000, 8000, 16 000 and 32 000 plants/ha. By 1978 the numbers of surviving plants represented 71.8, 56.4, 46.0, 24.1 and 14.5% respectively of the initial numbers planted. Data are presented on: mortality; mensurational details of the stands at ages 10, 13, 15, 18 and 30 yr; crown indices at 20 yr; and biomass data at 23 and at 30 yr. All the plantations have suffered from damage by Heterobasidion annosum, and the admixture of broadleaved trees and shrubs is seen as the only way of increasing the resistance of such plantations. The optimum planting density is 6000-8000 plants/ha, and pine should form at least 20% of this, so as to ensure at least 1000 healthy pine trees per ha when the plantation closes canopy."

Vashchenko, I.M. 1979. (Growth of sea buckthorn on sandy lands.) Lesn. Khoz. 2: 40-42. (Ru).
From Forestry Abstracts: "An account of the performance of Hippophaë rhamnoides planted in 1959 on sandy soils in the dry steppe region of SE Russia. Increment data are tabulated. It is concluded that H. rhamnoides grows poorly on infertile sands containing no humus, and fails to grow on aeolian quartz sands containing little moisture. It can be grown in the steppe and semi-desert zones on mantle sands rich in clay and colloidal particles with some humus and fresh groundwater accessible at a depth of 0.5-1.0 m, and also on meadow-bog sandy loam soils buried by sand. The optimum plant spacing is 4x3 and 4x2 m."

Veiga, A. De A. 1973. (Fertilizing in forestry.) Bras. Flor. 4(16): 26-30. (Pt, en).
From Forestry Abstracts: "Presents tables of fertilizer application rates developed as a guide to fertilizing in Pine and Eucalypt plantations established at a spacing of 2x2 m in Brazil. The tables show the application rates (in terms of the amount of element and fertilizer per plant and per ha) for $NaNo_3$, natural phosphate + superphosphate, and KCℓ, for soils of various retention capacity (low, average, above average, and high)."

Veldhoen, B.J. 1970. Interim report on RE:105 a thinning trial in Cupressus lusitanica. Kenya For. Dep., Tech. Note No. 105. 6 pp.
From Forestry Abstracts: "Presents a progress report on a thinning trial in an unthinned 7-year-old stand of C. lusitanica planted at an initial spacing of 8x8 ft in 1947 and having a density of 1400 stems/ha in 1954, in Elburgon Division, Kenya. Four (unreplicated) thinning treatments giving a constant periodic increase in growing space per tree were applied so that final crop density would be reached at age 15 in the most heavily thinned plot and at age 30 in the most lightly thinned plot. Growth measurements up to 1967 are given in tables. The main conclusions are that: (1) the thinning treatments influenced tree taper, and the height (only limited evidence for this) and diameter growth of the dominant trees; (2) at age 20 years the lightest thinning treatment yielded only 10-20% more total volume (to a 5-cm top) and 10-20% more merchantable volume (to a 15-cm top) than the heaviest thinning treatment, and (3) periodic variation in volume, b.a., and diameter increment was largely explained by variation in soil moisture."

Vlaheli, I.; Enescu, I. 1974. (Afforestation with conifers for pulpwood production by planting in 'biogroups'.) Rev. Pădurilor 89(4): 181-183. (Ro).
From Forestry Abstracts: "Describes three planting arrangements in square 'biogroups' of (a) 9, (b) 16 and (c) 25 plants (all spaced at 1.5x1.5 m) in a grid pattern with 3, 3.5 and 4 m respectively between the outer rows of trees in adjacent biogroups. Calculated data are tabulated on the areas and costs of site preparation and tending for each arrangement, compared with (d) planting the whole site with 3300 plant/ha. The total costs are only 55-60% of those of (d), (a) being the cheapest. Experience of the conversion of low-grade hardwoods in the Arges valley, Rumania, suggests that (a) is better for Pines and (b) or (c) for Picea abies. Other advantages are the establishment of and survival of trees at high stand densities and a more favourable light régime within the stand."

Volpato, E.; Schmidt, P.B.; Araujo, V.C. De 1973. (The condition of experimental plantings in the Ducke Forest Reserve 1. Twelve native forest species of Amazonia in enrichment plantings.) Acta Amazonica 3(1): 71-82. (Pt, en).
From Forestry Abstracts: "Tabulates data on the height and diameter increment of 12 species of native Amazonian hardwoods planted in 1964 in an enrichment trial in small plots (25 plants of each species, spacing 5x5 m) on an area cleared in 1962 near Manaus (cf. Schmidt and Volpato 1972). The species that have done best to date are Carapa guianensis, Cedrilinga cateniformis and Goupia glabra."

Vries, P.G. De; Hildebrand, J.W.; Graaf, N.R. De 1978. (Analysis of 11 years' growth of Caribbean pine in a replicated Graeco-Latin square spacing-thinning experiment in Surinam.) Meded. Landbouwhogesch. Wageningen No. 78-17. 58 pp. (En, nl).
From Forestry Abstracts: "A brief account is given of the history, ecology and silviculture of Pinus caribaea var. hondurensis in Surinam. Plots were established in 1965 at spacings of 2.5x2.5, 3x3 and 3.5x3.5 m with 6-month-old transplants. Low (17%), medium (21%) or heavy (25%) thinnings were made in 1972 and in 1975. Measurement data are summarized in yield tables for each spacing and thinning intensity. It is provisionally concluded that medium thinning and spacings of 2.5x2.5 and 3x3 are best for max. vol. production and more diversified production, respectively."

Vyskot, M. 1978. International research on the density of spruce populations. In: Proc. of the Eighth World For. Cong., Jakarta, Oct. 1978. iii+38 pp.
From Forestry Abstracts: "Data are presented on number of trees, d.b.h., ht., b.a., standing vol., tree class, flushing, bark characteristics, branchiness, attack by Armillaria (Armillariella) mellea, natural pruning and breakages, site class, canopy density, and crown characteristics for plots in an 89-yr-old stand of spruce established at spacings of 1x1, 1.5x1.5 and 2x2 m in Bedřichor, Czechoslovakia. Productivity was best at the 2x2 m spacing."

Wada, K.; Kodama, S.; Shibata, N.; Hara, H. 1972. (Studies on the growth production and the amount of nutrient elements of Alnus stand at different spacings. (1) Growth and production. (2) Amount of the nutrient elements in the soil, ground floor plants and litter.) Oji Inst. For. Tree Improvem., Tech. Note No. 114. 8 pp + summaries. (Ja, en).
From Forestry Abstracts: "(1) Tabulates and discusses data on the survival %, mean diameter, mean height and b.a. per ha, 4, 8 and 12 years after planting, of a plantation of Alnus hirsuta var. sibirica in southern Honshu planted at 500, 1000, 2000, 3000 and 5000 trees/ha, and on the dry-matter content per ha of the leaves, branches and stems 12 years after planting. (2) Tabulates data, for the same plantation, on the C, N, P, K, Ca and Mg contents of (a) the above-ground parts of the trees, (b) the ground flora, (c) the A_0 layer, and (d) the mineral soil. The nutrient content of (a) was substantially greater in the most densely stocked stand, but that of (b), (c) and (d) differed little between stands of different densities."

Walters, G.A. 1973. Growth of Saligna eucalyptus - a spacing study after 10 years. J. For. 71(6): 346-348.
From Forestry Abstracts: "Reports further on a study previously noticed. After 10 years, Eucalyptus saligna trees at all four spacings tested averaged >90 ft high. Average diameter ranged from 7.6 inches in the 8x8-ft spacing to 10.6 inches in the 14x14-ft spacing. The wider spacings appeared to be better than the narrow spacings for growing sawtimber."

Walters, G.A. 1980. Saligna eucalyptus growth in a 15-year-old spacing study in Hawaii. USDA, Forest Serv., Pacific Southwest For. Range Exp. Sta. Res. Pap. PSW-151. ii+6 pp.
From Forestry Abstracts: "Eucalyptus saligna seedlings were established in 1961 at 2.4, 3.0, 3.7 and 4.3-m spacing on the N slope of Mount Halcakala on the island of Maui to study the effects on sawn timber production. Data

for ht., d.b.h. and vol. growth up to 15 yr old are given. Yields of sawn timber were high (av. over 29 000 bd ft/acre at 15 yr old), and the widest spacings are recommended for economy of management and harvesting. Greatest vol. yield was at the 2.4-m spacing, but narrower spacings may further increase yield for pulpwood. Optimal spacing for combined pulpwood and saw log production is discussed."

Wang, T.T. 1977. Effects of different spacings on the biomass production of Cryptomeria stands. Nat. Taiwan Univ., Exp. For., Bull. 119: 1-30. (En, ch).
From Forestry Abstracts: "Fresh and dry weights were determined for samples of various components of the biomass taken from plots of Cryptomeria japonica established in 1952 in Taiwan at spacings of 1x1, 2x2, 3x3, 4x4 and 5x5 m. The wt. of individual sample trees and their components was greatest at the widest spacing, but the total Cryptomeria biomass on the plots was greatest at the closest spacing. The wt. of understorey vegetation was greatest at the widest spacing, whereas that of litter was greatest at the closest spacing; the total wt. of these 2 components combined showed no regular variation with spacing."

Ward, D.; Gardiner, J.J. 1976. The influence of spacing on tracheid length and density in Sitka spruce. Ir. For. 33(1): 39-56.
From Forestry Abstracts: "Measurements were made on Picea sitchensis trees planted in 1954 at spacings of 2.4x2.4 m (8 ft), 3.6x3.6 m (12 ft) and 4.57x4.57 m (15 ft). No significant differences in tracheid length were found between trees grown at different spacings. Tracheid length was significantly correlated with ring width (negative) and age from the pith (positive). Density of wood was significantly greater at narrow than at wide spacings."

Watterston, K.G. 1971. Growth of teak under different edaphic conditions in Lancetilla valley, Turrialba, Honduras. 21(2): 222-225. (En, es).
From Forestry Abstracts: "Comparison of four plantations aged 24 and 27 years on alluvial soil indicated that the most important factors affecting the growth of Teak were spacing and soil depth. Imperfect drainage on some sites did not appear to affect growth and form."

Wearstler, K.A., Jr. 1979. Competition - density effects and genetic improvement of yield components in loblolly pine (Pinus taeda L.) (Abstract). Diss. Abstr. Int., B40(4) 1443B.
From Forestry Abstracts: "Seventeen open-pollinated families were grown at three planting densities for two growing seasons. Significant family variation in height and root-collar diameter was found early in the study, but no variation existed among families at the end of the experiment owing to the spatial limitations on individual growth rates. Planting density also had a significant effect on heritability estimates of height and root-collar diameter, the heritability declining as the density increased."

Weihe, J. 1976. (Estimating growth space in pure stands.) Allg. Forst. Jagdztg. 147(4): 75-78. (De, en, fr).
From Forestry Abstracts: "Suggests that the expression of growing space, defined as the area available to a tree in relation to competing and interacting neighbours (and thus bordered by a zone of competition

determined by relative vigour) requires the inclusion of a dynamic factor, and that (because of the correlation between crown diameter and stem diameter) it could be defined quantitatively by reference to the product of d.b.h. and increment. Growing space would then bear the same relation to total stand area as this product bears to the sum total of these products for all trees in the stand. An example taken from a 93-year-old Spruce stand indicates that the new formula is consistent with the assumption that increment per m^2 of growing space is equal within a stand, whereas other formulae based on diameter relations, e.g. Prodan's (cf. FA 30, 2834), tend to overestimate the growing space of smaller trees of less competitive vigour."

Weihe, J. 1978. (Assessment of the area and boundary of growing space in single-storeyed pure stands.) Allg. Forst. Jagdztg. 149(2/3): 40-44. (De, en, fr).
From Forestry Abstracts: "(See Weihe 1976) The author stresses the idea of horizontal growing space as a growth-related area depending on competition between a tree and its neighbours. Basal area increment describes the competitive status of a tree more accurately than the product of girth and girth increment; this measure of growing space has therefore been abandoned. The use of polygons to indicate the boundaries of the growing space has been adapted to the method of assessment using b.a. growth."

Westra, J.J. 1975. (Stem analysis of Larix leptolepis.) Landbouwkd. Tijdschr. 87(1): 2-6. (Nl).
From Forestry Abstracts: "Discusses stem analyses made in 1964/1966 on mean stems in stands planted at Drente, Netherlands, between 1920 and 1950 at widely differing spacings (cf. FA 29, 4370), supplemented by stem analyses from the same stands in 1973 and from other stands at other dates. The later development of individual trees which at a given earlier time had the same dimensions sometimes differed greatly; after unfavourable growth conditions, which appeared to include periods of excessive stand density, attacks by sawflies, and drought, a remarkable capacity for recovery could be discerned. Results did not contribute to the achievement of the original aim of the study, namely to find the most suitable spacing (especially in order to avoid uneconomic thinnings). However, they showed a relative improvement of growth, with increasing age, as compared with Dutch yield tables, especially so in the densely planted stands with slow early growth."

Whitesell, C.D. 1974. Effects of spacing on loblolly pine in Hawaii after 11 years. USDA, Forest Serv., Pacific Southwest For. Range Exp. Sta. Res. Note PSW-295. 4 pp.
From Forestry Abstracts: "Results in Nov. 1971 are tabulated for a Pinus taeda trial established on Maui island in Jan. 1961 at initial spacings of 6, 8, 10 and 12 ft. Survival was >94%; mean d.b.h. and b.a. ranged from 6.4 in and 168 ft^2/acre at 6-ft to 9.8 in and 278 ft^2/acre at 12-ft spacing; mean height was ca. 40 ft for all spacings; and 44% of the stem was in the live crown in trees at 6-ft and 64% in trees at 12-ft spacing."

Whitesell, C.D. 1975. Growth of young saligna eucalyptus in Hawaii: 6 years after thinning. USDA, Forest Serv., Pacific Southwest For. Range Exp. Sta. Res. Note PSW-299. 3 pp.

From Forestry Abstracts: "A 6-year-old stand of Eucalyptus saligna was thinned from below to leave residual densities of 100, 85 or 70 ft² b.a./acre. During the next 6 years, no significant differences in growth were found between the treatments. A preliminary conclusion is that stands of E. saligna planted at 10x10-ft spacing on similar sites should not require thinning until density has reached 200 ft² b.a./acre at about 15 years old."

Whitmore, J.L.; Liegel, L.H. 1980. Spacing trial of Pinus caribaea var. hondurensis. USDA, For. Serv., South. For. Exp. Sta. Res. Pap. SO-162. 8 p.
From Forestry Abstracts: "At 4 upland sites in Puerto Rico, triangular spacings of 5x5, 7x7, 10x10, and 14x14 ft were used; sites were measured at tree ages ranging from 11.5 to 13.6 yr. Survival averaged over 80% at all sites and was not related to spacing. M.a.i. (ht. and diam.) increased, whereas m.a.i. (b.a. and vol.) decreased as spacing increased; rates were at least as good as rates reported in other countries. Number of trees/acre with d.b.h. 5 inch or more decreased as spacing increased; at 5x5 ft there were no trees with d.b.h. 12 inch or more. Density (based on increment borer whole-core samples) averaged 0.48 (range 0.41-0.55) with lowest densities at narrowest spacings. Recommended spacing regimes are given for various end uses."

Wiant, H.V., Jr. 1973. Efficiency of regular spacing planting designs. Tree Planters' Notes 24(3): 31-32.
From Forestry Abstracts: "The amount of space available when circular crowns meet in a plantation varies according to the planting design used: square and superposed square designs give 22%, rectangular designs >22% and equilateral triangle designs 9% of such space. In theory, the filling of this space would take place at a slower rate since the crown is no longer free to expand in all directions."

Wick, H.L.; Nelson, R.E.; Landgraf, L.K. 1971. Australian Toon planted in Hawaii: tree quality, growth and stocking. USDA, Forest Serv., Pacific Southwest For. Range Exp. Sta. Res. Pap. PSW-69. 10 pp.
From Forestry Abstracts: "A study was made of 5- to 8-year-old plantations of Toona australis, T. australis/Fraxinus uhdei, and T. australis/Acacia koa on the Waiakea-Olaa reforestation area, Hawaii, to assess stocking (survival), and tree growth and quality in relation to soil depth, micro-topography, soil drainage and parent rock. Data are tabulated and recommendations are made on site suitability, spacing, and silvicultural measures to improve plantations of T. australis."

Williston, H.L. 1978. Thinning shortleaf pine plantations in northern Mississippi. South. J. Appl. For. 2(4): 137-140.
From Forestry Abstracts: "Eight thinning treatments were applied in 1957, 1961, and 1966, to 23-yr-old plantations of Pinus echinata originally spaced at 6x6 ft. All trees with d.b.h. over 2 inches were inventoried every 5 yr until 1977 in the central 0.1 acre of 24 plots (0.4 acre) on 3 site types of site indices (SI) 80, 75 and 71; the number of 16-ft logs in trees of d.b.h. 9.6 inches and larger was estimated. Stand and stocking data are tabulated for 1957-77 with p.a.i. and total yield/acre. Further information was recorded on crop trees (10/plot) with potential for production of high-quality saw logs. Residual b.a. made n.s.d. to cubic

vol. increment over 20 yr, but b.a. at 38-yr-old had a highly significant effect on bd ft vol. increment in the next 5 yr. Bd ft yield was also significantly affected by site, being highest for SI 80 (12 334 bd ft/acre at 43-yr-old). Crop trees were identifiable at 23-yr-old. The results suggested that thinnings should be heavy, and that an original spacing of 8x8 ft would have increased yield."

Williston, H.L. 1979. Growth and yield to age 37 in north Mississippi loblolly plantations. South. J. Appl. For. 3(3): 127-130.
From Forestry Abstracts: "Plantations of site indices 80 and 90, 17-yr-old in 1957, were thinned 3x at 5-yr intervals to b.a. 70 and 100 ft^2/acre. After 20 yr, production/acre on sites of index 90 was 5274 and 6215 ft^3 respectively after thinning to 70 and 100 ft^2/acre; comparable figures for sites of index 80 were 4390 and 4692 ft^3/acre. Heavy thinning reduced cordwood yield by 15% on sites of index 90, and 6% on sites of index 80. Data are also presented for periodic annual growth of cordwood, bd ft, and diam., changes in crop tree characteristics, and mortality. It is suggested that the original spacing of 6x6 ft in these plantations was too close. Different thinning regimes and a spacing of 8x8 ft are recommended."

Wittwer, R.F.; Immel, M.J. 1978. A comparison of five tree species for intensive fibre production. For. Ecol. Manage. 1(3): 249-254.
From Forestry Abstracts: "Total ht., diam. increment, mortality and aboveground biomass production were measured in closely-spaced (0.9x0.6 m) plantations of hybrid poplar, American sycamore (Platanus occidentalis), European alder (Alnus glutinosa), river birch (Betula nigra) and green ash (Fraxinus pennsylvanica) in Kentucky. Relative ranking for all characteristics were in the above order of species (greatest first)."

Wittwer, R.F.; King, R.H.; Clayton, J.M.; Hinton, O.W. 1978. Biomass yield of short-rotation American sycamore as influenced by site, fertilizers, spacing, and rotation age. South. J. Appl. For. 2(1): 15-19.
From Forestry Abstracts: "Platanus occidentalis was planted on bottomland and terrace sites in the Ohio River Valley region of western Kentucky. Without fertilizer treatment, the bottomland site was more productive, but yields from fertilized plots on the two sites were comparable. Treatment with N significantly increased yields of all biomass components. Yields of stemwood and bark increased with closer spacings. Av. annual production, excluding leaves, for the best combination (6x3 ft spacing; N fertilization; and 5-yr rotation on the terrace) was approx. 6 tons/acre on a green-wt. basis. Without fertilization, the 1x3 ft spacing was most productive, yielding annually nearly 4 tons/acre after either the 3- or 4-yr rotation period on the bottom site."

Wood, B.W.; Carpenter, S.B.; Wittwer, R.F. 1976. Intensive culture of American sycamore in the Ohio River Valley. Forest Sci. 22(3): 338-342.
From Forestry Abstracts: "Plantations of Platanus occidentalis were established on a flood-plain and a terrace site in Kentucky, in 1971, to study short-rotation yields. Three spacings (0.3x0.9 m, 0.9x 0.9 m and 1.8x0.9 m) were combined with N or NP fertilizer treatments applied each year for 3 years. The stands were felled at 3 years old. Data are tabulated on survival, height, diameter, fresh and dry weights, and the components of the biomass. Highest yields were in general obtained at the

closest spacing and with N fertilizing (169 kg/ha year of N) on both sites, correpsonding to a total yield of 14-15 t/ha dry weight. The m.a.i. is ca. 12 times that of long-rotation mixed hardwoods."

Wood, B.W.; Wittwer, R.F.; Carpenter, S.B. 1977. Nutrient element accumulation and distribution in an intensively cultured American sycamore plantation. Plant and Soil 48(2): 417-433.
From Forestry Abstracts: "Biomass and nutrient uptake under various spacings (0.3x0.9 m, 0.9x0.9 m, 1.8x0.9 m) and fertilizer treatments (none, 169 kg/ha N, 169 kg/ha N + 112 kg/ha P) were measured by total tree analysis techniques for Platanus occidentalis seedlings grown on either a floodplain or a terrace site in western Kentucky. Stands were planted as 1+0 stock and harvested after 3 growing seasons. Nutrient element concn. was affected by site and fertilizer but not by spacing. biomass yield was max. at 0.3x0.9 m spacing. Branches and foliage contained 45-70% of nutrient elements present in above-ground tree parts. Consideration of the soil nutrient cycle suggests that removal of all above-ground tree parts could reduce soil P concn., but that other soil nutrients would be unaffected."

Yang, Y.C. 1972. (Comparison of the effect of thinning on stands of Cryptomeria japonica of seedling and vegetative origin in Taiwan.) Exp. For. Nat. Taiwan Univ., Tech. Bull. No. 98. 21 pp. (Ch, en).
From Forestry Abstracts: "Plantations made with 1+0 stock, (a) raised from seed and (b) raised from cuttings, both initially spaced at 2x2 m, were thinned at 17 years of age, with four different thinning intensities. Before thinning, (a) and (b) showed no significant difference in total b.a. or volume/ha and had a similar stand structure. When assessed 3 years later, (a) and (b) still showed no significant difference in standing volume, thinning yield, volume increment or stand structure (diameter frequency distribution). There were, however, significant differences between thinning intensities, the heaviest thinning giving uniformly the best results."

Yang, Y.C.; Chen, C.M.; Lee, K.C.; Lin, W.L. 1976. (Studies on the stand density of plantation.) Exp. For. Nat. Taiwan Univ., Bull. 117: 25-42. (Ch, en).
From Forestry Abstracts: "Six methods of measuring stand density were assessed, using stand data from Cryptomeria japonica plantations, viz: trees/unit area; b.a./unit area; stand density index; stand vol./unit area; spacing index; and crown competition factor. Spacing index and crown competition factor were found to be the most successful; they are both correlated with vol. growth and are independent of stand age. The tables and graphs have English captions."

Yurov, I.V. 1975. (Growth of plantations of Pinus koraiensis.) Lesn. Khoz. 12: 60-62. (Ru).
From Forestry Abstracts: "Gives details of the performance of P. koraiensis in plantations on three sites in the Maritime Province of the Soviet Far East, viz. (1) on an old-field site, ploughed and planted at a spacing of 1.5x0.8 m; (2) in strips 3-3.5 m wide cut in a second-growth stand of Quercus mongolica and other native hardwoods 29 years old, the Pine being planted 0.7-0.8 m apart in two rows in each strip; and (3) underplanting in the second-growth hardwood stand described in (2), in

quincunx formation on prepared patches of 1x1 m. The survival and growth of the Pine are tabulated for the first 6 years. In (3) survival was high but growth was slow, and this method is not recommended. The best method of plantation establishment was (2), but it is necessary to control the broadleaved scrub in and at the edges of the strips regularly from the second or third year after planting."

Zajaczkowski, J. 1973. (The initial spacing for Scots pine is still in dispute.) Sylwan 117(11): 8-15. (Pl, ru, en).
From Forestry Abstracts: "A review of Central and East European literature on initial spacing for Scots Pine plantations. The author concludes that there is as yet no scientific basis for increasing the distance between the rows above 1.3 m and the distance between 1-year-old seedlings in the rows above 0.6 m (this corresponds to 13 000 seedlings/ha)."

Zakhariev, B.; Iliev, S. 1980. (Comparative studies on experimental one-year and two-year poplar stool-beds.) Gorskostop. Nauka 17(1): 70-75. (Bg, ru, de).
From Forestry Abstracts: "Investigations were made to determine the best types of stool-beds for the production of cuttings of poplars (Populus 'I-214', P. 'I-262', P. 'I-455', P. 'Weltheimeipappel', P. 'Vernirubens', and P. 'Bachelieri'). Spacings of 1.4x0.1, 1.4x0.2, 1.4x0.5, and 1.4x1.0 m were used in 1-yr and 2-yr stool-beds. The best spacing in 1-yr beds was 1.4x0.2 m. The greatest number of cuttings in 2-yr beds was obtained with spacings of 1.4x0.1 and 1.4x0.2 m. It is believed, however, that a wider spacing of 1.4x0.5 m offers the best prospects for the following years."

Zakhariev, B.; Iliev, S.; Mitev, T. 1975. (Growth and productivity of some hybrid black poplar clones in Bulgaria on sites close to rivers and on dry sites away from rivers.) Gorskostop. Nauka 12(2): 16-22. (Bg, ru, de).
From Forestry Abstracts: "Compares the performance up to age 11 or 12 years of 7 clones planted in two plantations, viz. (1) a flood-plain site with alluvial soil and high water table, initial spacing 6x4 m; and (2) a dry carbonate-chernozem site with low water table, initial spacing 5x5 m. M.a.i. on site (1) was generally ca. 5 times that on site (2). For example, Populus 'I-214', the best clone, had a m.a.i. of 32.8 m^3/ha on (1) as against only 5.1 m^3/ha on (2)."

Zavitkovski, J. 1976. Biomass studies in intensively managed forest stands. In: Intensive plantation culture - five years research. USDA, Forest Serv. North Central For. Exp. Sta. Gen. Tech. Rep. NC-21: 32-38.
From Forestry Abstracts: "It is emphasized that whole-tree utilization and pulping systems require that forest products be measured in wt. rather than vol. Sampling methods and allometric relations are outlined for determination of standing biomass. Results are presented of a study in a 3-yr-old Populus 'Tristis No. 1' plantation in which measurement of (a) leaf litter and (b) canopy leaf biomass (both in t/ha) and (c) light intensity (ft-candles; vs. light in the open) were taken under 4 spacing regimes. Spacings of 1x1 and 2x2 ft gave highest values for (a) and (b); at spacings of 4x4 and 8x8 ft, values were much lower."

Zavitkovski, J. 1981. Small plots with unplanted plot border can distort data in biomass production studies. Can. J. Forest Res. 11(1): 9-12. (En, fr).

From Forestry Abstracts: "In small (49-660 m²), densely planted (square spacing of 0.3-2.4 m), open-sided plots of Populus 'Tristis No. 1', tree mortality increased, and d.b.h., DM content, foliage wt. and leaf area index decreased from the border row to the centre rows. Edge trees tended to spread outward, receiving more solar radiation and irrigation water than those in the centre of the plots. The 'edge effect' extended through more rows in closely than in widely spacing plots. Methods are suggested for reducing this effect in production studies."

Zavitkovski, J.; Dawson, D.H. 1977. Structure and biomass production of 1 to 7-year-old intensively cultured jack pine plantations in Wisconsin. USDA, Forest Serv., North Central For. Exp. Sta. Res. Pap. NC-157. 15 pp.
From Forestry Abstracts: "Three spacings were tested (9x9, 12x12, and 24x24 inches) and related to survival and growth (ht. d.b.h., and dry wt. of tree components). Av. ht. and d.b.h. growth and survival increased with spacing. Until 5 yr old total above ground biomass decreased with increasing spacing. At 7 yr old total dry wt., m.a.i. and c.a.i. were least at the 9x9 spacing; m.a.i. was greatest at the 12x12 spacing and c.a.i. at the 24x24 spacing. With increasing spacing % of branches and needles increased and % of stem and branch bark decreased. There was a positive relation between living needle biomass and current annual production (c.a.p. = c.a.i. + dead dry wt.) of stems and branches. Opt. rotation lengths - at the peak mean annual production of stems and branches (m.a.p., cf. c.a.p.) - were 6 yr for 9x9 spacing, 7 yr for 12x12 spacing and not yet reached for the 24x24 spacing. The importance of irrigation is emphasized."

Zavitkovski, J.; Dawson, D.H. 1978. Structure and biomass production of 1- to 7-year old intensively cultured tamarack plantations in Wisconsin. Pages 29-35 in Proc. of the TAPPI Annual Meeting, Chicago, Illinois, March 1978.
From Forestry Abstracts: "Stands of tamarack were initially spaced at (a) 0.23x0.23, (b) 0.3x0.3 and (c) 0.61x0.61 m. At 7-yr old, stem plus branch biomass averaged 36.4, 30.1, and 33 t/ha and m.a.i. averaged 5.2, 4.3, and 4.7 t/ha respectivley for (a), (b) and (c). Biomass production of (a) was comparable to that of similarly spaced jack pine, but at wider spacing jack pine produced 20-45% more. Tamarack was considered less adaptable and less suitable for short rotation intensively cultivated plants that jack pine or Populus 'Tristis No. 1'."

Zavitkovski, J.; Jeffers, R.M.; Nienstaedt, H.; Strong, T.F. 1981. Biomass production of several jack pine provenances at three Lake States locations. Can. J. For. Res. 11(2): 441-447. (En, fr).
From Forestry Abstracts: "Total biomass, biomass production, component distribution and m.c. of stems and branches were estimated in 24- and 25-yr-old jack pine stands of 4 provenances planted at 3 sites in Michigan, Minnesota and Wisconsin, USA. The initial spacing was 1.5x1.5 m. Total biomass and mean annual biomass production (MAB) were negatively correlated to lat. The overall range of MAB was 2.6-5.8 t/ha per yr. The highest MAB was 58% higher than the max. reported in the literature. Stems accounted for 64-75% and branches with needles for the rest of the aboveground biomass. Stem % decreased at the northernmost location. Stems of all harvested trees had a significantly higher m.c. (127-141% on a dry wt. basis) than their branches with needles (100-115%). M.c. was lowest in

March. The study showed that suitable seed source selection is a very important factor in increasing jack pine stand production in the Lake States. From authors' summary."

Zhelev, I. 1971. (Growing space and canopy density as related to an individual tree.) Gorskostop. Nauka 7(1): 33-51. (Bg, ru, de).
From Forestry Abstracts: "Discusses various theories and models of growing space and canopy density (i.e. crown cover/growing space) as applied to an individual tree in a stand. Various formulae are developed to assist in the calculations, and a model is developed for density 1.0 of the individual tree. This shows that, with a given tree spacing, density is directly proportional to the crown radius for trees with non-overlapping crowns, and inversely proportional to the crown radius for trees with overlapping crowns. Determination of this density value for individual trees improves the accuracy of density estimates for groups and stands."

Zhelev, I. 1976. (The initial density of pine plantations.) Gorskostop. Nauka 13(4): 13-23. (Bg, ru, de).
From Forestry Abstracts: "Reviews some of the European literature on planting density for Pinus sylvestris, and describes the results of planting density trials in Bulgaria in which numerous initial plant spacings from 0.5x0.5 m to 4.0x4.0 m were compared for Pinus sylvestris and P. nigra. Data are given on plantations density at ages 5, 10 and 15 years. Analysis of the results indicates that on good sites (I, II and III) and for commercial plantations an initial density giving 4-9 m^2 of growing space per plant is appropriate, with canopy closure at 10-15 years, and a rotation of 30-100 years. On poor sites (IV and V) and for erosion-control plantings, an initial density giving a growing space of 1-4 m per plant is appropriate, with canopy closure at 10-15 years and a rotation from 30 years to the age of natural mortality of the plantations. In exceptional cases, e.g. for immediate coverage of steep slopes, initial planting densities giving a growing space of even less than 1 m^2 per plant may be used."

Zhuravleva, M.V.; Shestakova, V.A. 1981. (Growth of Scots pine and Norway spruce in relation to plantation density and composition.) Lesn. Khoz. 4: 24-26. (Ru).
From Forestry Abstracts: "An investigation was made of the growth of pine and spruce in pure and mixed plantations, 20-30 yr old, on medium and heavy clay-loam soils in the Moscow region. The plantations had been established at various planting densities on several different site types. Data are tabulated on the number of stems/ha, mean ht. and diam., and standing vol. Both pine and spruce grow well in relatively open pure plantations with an initial spacing of 1.5-2x8-1 m and a density of 1000-3000 trees/ha at 20-30 yr. In mixed pine/spruce plantations the pine grows well but the spruce is inferior to spruce in pure plantations of the same age; the introduction of the spruce appears to create favourable conditions for the nutrition and growth of the pine."

Zimmermann, H. 1982. (Growing Norway spruce in Hesse.) Allg. Forstz. 16: 455-458. (De).
From Forestry Abstracts: "Topics covered in this review include: history; site preferences; recommended provenances; establishment, tending and early/late thinnings; and mixing of spruce with beech. Current

silvicultural practice emphasizes: row planting (approx. 3000 plants/ha) vs. narrower spacings; free thinnings vs. thinning from below; and avoidance of establishment of pure spruce stands, particularly on sites well suited for beech/oak."